INSTRUCTION MANUAL

MODEL 1130
PROGRAMMABLE
DISTORTION ANALYZER

BOONTON
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IMPORTANT NOTICE
MAY 26, 1993

INSTRUCTION MANUAL-ADDENDUM: MODEL 1130

Instruction manual addenda are issued to adapt the manual to changes and improvements made after its printing. Please review the following text and retain with your manual for future reference. These changes will be applied in the next printing of the manual.

Thank you for selecting Boonton Electronics for your Test and Measurement needs.

Page 6-4 Change C11-12 information to:

CAP MICA 20,000 pF 5% 500 V
51406 GP5203MF 2 20302000A

Add: C34 CAP MICA 18 pF
14655 CD5CC180J 1 205046000

Add: C35 CAP TRIM 5-30 pF
91293 9383 1 28102800A

Change F1-2 information to:
FUSE 1/4 AMP
55426 AGC-1/4 2 545518000

Page 6-8 Because C17 is a factory selected value add the following possibilities to the parts list.

8pF 10% 300 V 14655
CD5CC080D 1 205001000

10pF 5% 300 V 14655
CD5CC100J 1 205002000

12pF 5% 300 V 14655
CD5CC120J 1 205005000

Page 6-10 Delete R29

Page 7-5 Figure 7-3:

Change F1 and F2 from 1/16 A to 1/4 A.

Add a fixed capacitor C34, 18pF between ground and the junction of R27 and R28.

Add a trimmer capacitor C35, 5-30pF between ground and the junction of R27 and R28.

Page 7-13 Add: Figure 7-10. Detector Board A3 Schematic to the title area.

For C17 remove 15 pF and replace with:

Factory selected value, see parts list for selections.

Page 7-19 Figure 7-14. Delete R29

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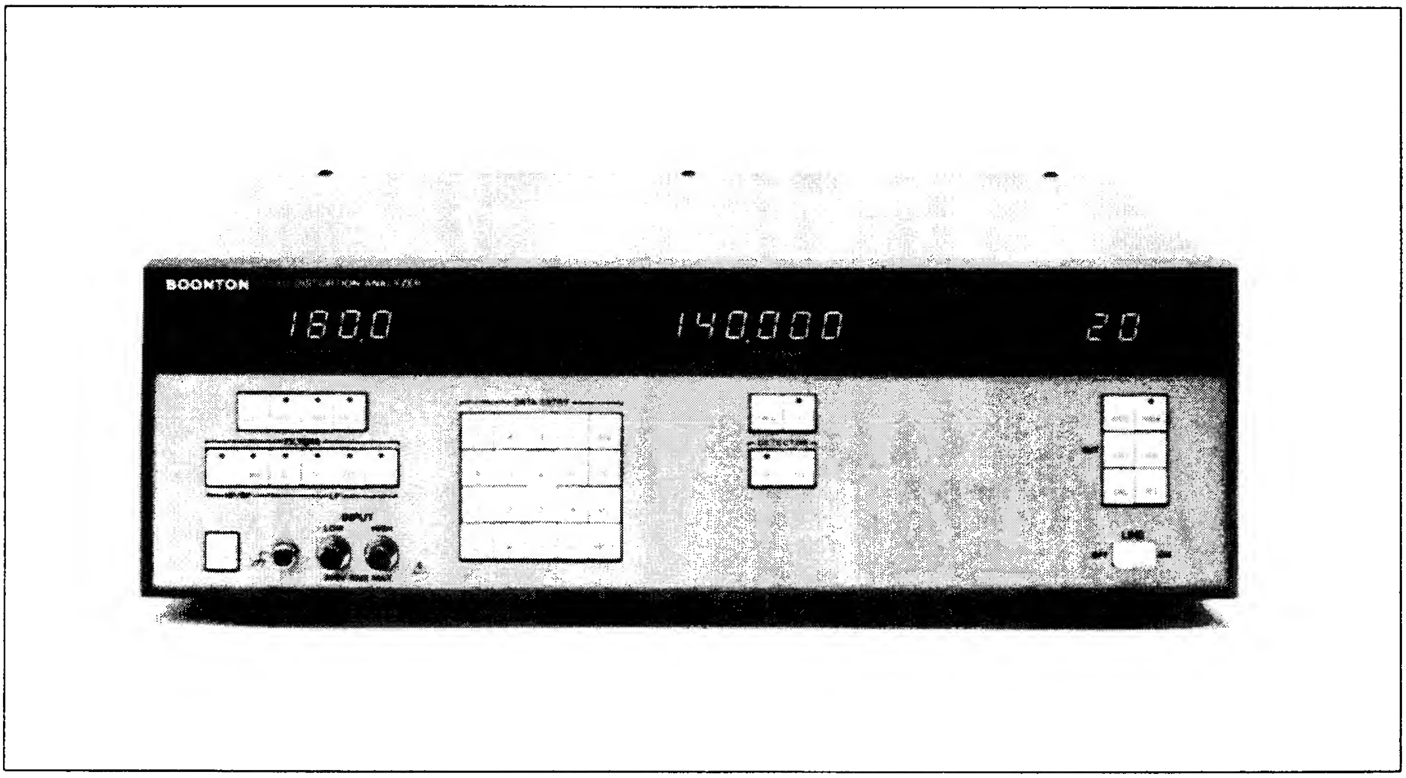


MODEL 1130 DISTORTION ANALYZER

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This instruction manual provides installation, operating and maintenance instructions, theory of operation, schematics and parts lists for the Model 1130 Distortion Analyzer.

1-3. DESCRIPTION.

1-4. The Model 1130 is a versatile, precision, solid-state instrument with features and performance characteristics especially suited to laboratory and industrial applications. Human engineering considerations have been emphasized in both the mechanical and electrical design of the Model 1130. The result is a distortion analyzer that is easy and convenient to use. Among the outstanding features are:

a. **Versatile distortion analyzer.** Advanced measurement techniques enable the Model 1130 to provide fast, accurate measurements. Measurement modes include frequency, AC or DC level, distortion, SINAD, and full ratiometric capability.

b. **Separate Displays of All Major Functions.** The Model 1130 has 3 separate display windows to simultaneously present frequency measurements, amplitude measurements, and program number or bus address information. Continuous display of IEEE-488 bus status is also presented.

c. **Full Range of Filter Selections.** The Model 1130 provides a wide range of filter selections and weighting characteristics for industry-standard audio measurements.

d. **Balanced Input.** The Model 1130 has a fully differential/balanced input for testing bridged amplifiers and power supplies.

e. **Instrument Setup Memory.** Up to 99 front panel setups containing all data required to configure the analyzer to a previous operating mode can be stored in non-volatile memory for future recall. The last valid instrument setup before power interruption is also saved automatically and restored when power is resumed.

f. **IEEE-488 Interface Bus.** All instrument functions are programmable except bus address. Annunciators to the left of the BUS/PRGM display window show the status of bus activity. The 1130 is designed to interface easily with controllers currently in use. A versatile free-form number entry system is used so that the 1130 will accept any conceivable valid number string. Triggering may be performed in immediate or wait modes. There are five talk modes which can be addressed in either the remote or local state. The 1130 also provides a choice of several end-of-string terminators. Service-request (SRQ) can be asserted on errors or using the front panel SRQ key and the LCL/INIT key will force return to local control when using the bus as long as a lockout message has not been sent.

1-5. ACCESSORIES.

1-6. The following accessories are supplied with the instrument:

AC power cord
Spare input fuses

The following accessories are available:

950044	Rack mounting hardware
950043	Chassis slide kit
95401801A	Single binding post to BNC (M) adapter
95401901A	BNC (F) to phono plug
95402001A	Phono jack to BNC (M)
95402104A	Two conductor shielded balanced line, 36 inches
95402201A	XLR connector to three banana plugs

1-7. OPTIONS.

1-8. The following options are available:

- -01 Rear panel input connectors
- -11 400 Hz high-pass filter
- -12 CCITT weighting filter
- -13 CCIR weighting filter
- -14 CCIR/ARM weighting filter
- -15 A weighting filter
- -16 B weighting filter
- -17 C weighting filter
- -18 Audio band-pass filter
- -19 C-MESSAGE filter

1-9. SPECIFICATIONS.

1-10. Performance specifications for the Model 1130 Distortion Analyzer are listed in Table 1-1.

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

ANALYZER SPECIFICATIONS

Frequency Measurement

Range: 5 Hz to 200 kHz
Sensitivity: 3 mV
Accuracy: Timebase accuracy +- 1 count
Resolution:
0.001 Hz; 5.000 to 199.999 Hz
0.01 Hz; 200.00 to 1999.99 Hz
0.1 Hz; 2.0000 to 19.9999 kHz
1.0 Hz; 20.000 to 199.999 kHz

Timebase

Type: 10 MHz TCXO
Accuracy: +- 1 ppm/yr

AC Level Measurement

Range: (full scale)
300.0 V, 30.00 V, 3.000 V,
300.0 mV, 30.00 mV, 3.000 mV
Overrange: 20 % except on 300 V range
Accuracy:
+- 1 %; 50 Hz to 50 kHz, 1 mV to 300 V
+- 2 %; 20 Hz to 100 kHz, 1 mV to 300 V
+- 3 %; 10 Hz to 100 kHz, 1 mV to 300 V
Flatness: (1 mV to 300 V)
+- 0.5 %; 50 Hz to 50 kHz
+- 1.0 %; 20 Hz to 100 kHz
+- 2.0 %; 10 Hz to 100 kHz

DC Level Measurement

Range: (full scale) 300.0 V, 30.00 V, 3.000 V
Overrange: 20 % except on 300 V range
Accuracy: +- 0.3 % + 10 counts

Common Mode Rejection Ratio

CMRR:
70 dB; 20 Hz to 1 kHz
45 dB; 1 KHz to 20 kHz
Limits:
4.25 V pk; 3.000 V range
42.5 V pk; 30.00 V range
425 V pk; 300.0 V range

Analyzer Input

Type: Balanced (full differential)
Impedance:
100 k ohms +- 1 %, < 300 pF, each side to ground
Protection:
Excessive common mode levels are hardware limited on all input ranges and fuse protection is employed against peak levels exceeding 425 volts

Distortion Measurement

Fundamental Frequency Range:
10 Hz to 100 kHz usable to 140 kHz
Resolution:
0.0001 %; < 1.1000 %
0.001 %; < 11.000 %
0.01 %; < 100.00 %
Display Range:
0.0001 to 100.00 % (-120.00 to 0.00 dB)
Accuracy:
+- 1 dB; 20 Hz to 20 kHz
+- 2 dB; 10 Hz to 100 kHz
Input Voltage Range: 10 mV to 300 V
Distortion Measurement Range:
0.01 % (-80 dB) or 10 uV;
10 Hz to 20 kHz, 80 kHz bandwidth
0.02 % (-74 dB) or 20 uV;
20 to 50 kHz, 220 kHz bandwidth
0.056 % (-65 dB) or 50 uV;
50 to 100 kHz, 500 kHz bandwidth

SINAD Measurement

Fundamental Frequency Range:
10 Hz to 100 kHz usable to 140 kHz
(manually tuned)
Display Range: -120.00 to 0.00 dB
Accuracy:
+- 1 dB; 20 Hz to 20 kHz
+- 2 dB; 10 Hz to 100 kHz
Input Voltage Range: 10 mV to 300 V
SINAD Measurement Range:
same as for distortion measurement

Standard Audio Filters

30 kHz Low-pass Filter
Accuracy: 30 kHz +- 2 kHz
Rolloff: Third-order Butterworth, 60 dB/decade

80 kHz Low-pass Filter
Accuracy: 80 kHz +- 4 kHz
Rolloff: Third-order Butterworth, 60 dB/decade

220 kHz Low-pass Filter
Accuracy: 220 kHz +- 20 kHz
Rolloff: Third-order Butterworth, 60 dB/decade

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

Optional Audio Filters

400 Hz High-pass Filter
Accuracy: 400 Hz +- 40 Hz
Rolloff: Seventh-order Butterworth, 140 dB/decade

Audio Band-pass Filter
Accuracy:
22.4 Hz +- 5 %, 60 dB/decade rolloff
22.4 kHz +- 5 %, 60 dB/octave rolloff

A, B, C Weighting Filter
Accuracy:
+- 0.2 dB; 1.0 kHz
+- 1.0 dB; 40 Hz to 5.0 kHz
+- 1.5 dB; 25 to 40 Hz, 5.0 to 10.0 kHz
+- 2.0 dB; 20 to 25 Hz, 10.0 to 20.0 kHz

CCITT or C-MESSAGE Band-pass Filter
Accuracy:
+- 0.2 dB; 800 Hz CCITT,
+- 0.2 dB; 1000 Hz C-MESSAGE
+- 1.0 dB; 300 to 3000 Hz
+- 2.0 dB; 50 to 300 Hz, 3.0 to 3.5 kHz
+- 3.0 dB; 3.5 to 5 kHz

CCIR or CCIR/ARM Band-pass Filter
Accuracy:
+- 0.2 dB; 6.3 to 7.1 kHz
+- 0.4 dB; 7.1 to 10 kHz
+- 0.5 dB; 200 to 6300 Hz
+- 1.0 dB; 31.5 to 200 Hz, 10 to 20 kHz
+- 2.0 dB; 20 to 31.5 kHz

SUPPLEMENTAL INFORMATION

AC Measurement

RMS Detector:
True rms responding for signals with a crest factor of <3
Average Detector:
Average responding rms calibrated
Bandwidth: 500 kHz

Frequency Measurement

Technique:
Reciprocal measurement with 10 MHz timebase

Analyzer Measurement Speed

Function:	First Reading:	Rate:
Frequency	< 1 sec	4 rdngs/sec
Level	< 1 sec	10 rdngs/sec
Distortion	< 1 sec	8 rdngs/sec
SINAD	< 1 sec	8 rdngs/sec

General Information

Power Requirements:
100, 120, 220, 240 volts AC, 50 to 400 Hz, 40 VA
Operating Temperature:
0 to 55 degrees centigrade

Dimensions:
17.75 inches (45.1 cm) wide, 5.85 inches (14.9 cm) high, 18 inches (45.8 cm) deep
Weight: 25 lbs (11.3 kg)
Accessories Included:
Spare input fuses and AC power cord
Accessories Available:
950044 Rack mounting hardware
950043 Chassis slide kit
954018 Single binding post to BNC (M)
954019 BNC (F) to phono plug
954020 Phono jack to BNC (M)
954021 Two conductor shielded balanced line, 36"
954022 XLR Audio connector to three banana plugs
Options:
-01 Rear panel input
-11 400 Hz high-pass filter
-12 CCITT band-pass filter
-13 CCIR band-pass filter
-14 CCIR/ARM band-pass filter
-15 A weighting filter
-16 B weighting filter
-17 C weighting filter
-18 Audio band-pass filter
-19 C-Message band-pass filter

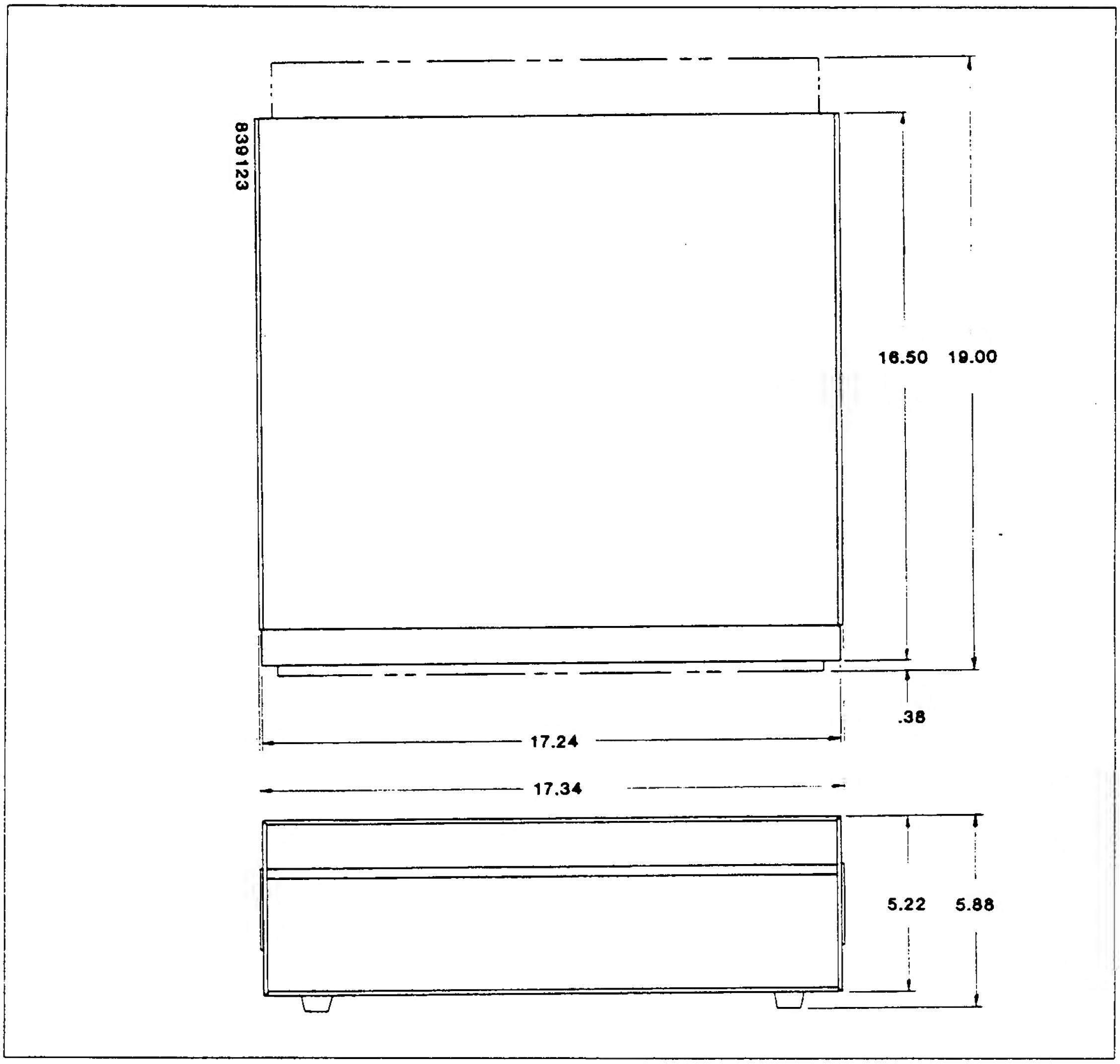


Figure 1-1. Outline Dimensions.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains the unpacking, mounting, power requirements, cable connections, and preliminary check-out instructions for the Model 1130 Distortion Analyzer.

2-3. UNPACKING.

2-4. The instrument is shipped complete and is ready to use upon receipt. Unpack the instrument from its shipping container and inspect for damage that may have occurred during shipment. Refer to Figure 2-1.

NOTE

Save the packing material and container for possible use in reshipment of the instrument.

2-5. MOUNTING.

2-6. For bench mounting choose a clean, sturdy, uncluttered mounting surface. For rack mounting, an accessory kit is available which provides mounting ears. The rack mounting kit contains the required hardware and instructions.

2-7. POWER REQUIREMENTS.

2-8. The instrument has a tapped power transformer and two line voltage selection switches which permit operation from 100, 120, 220, or 240 volt +-10 %, 50 to 400 Hz, single phase AC power sources.

CAUTION

Always make certain that the line voltage selection switches are set to the correct positions corresponding to the voltage of the AC power source, and that a fuse of the correct rating is installed before connecting the instrument to any AC power source.

2-9. Set the rear panel line voltage selector switches to the appropriate positions as indicated in the Line Voltage Select Chart and check that the line fuse is correct for the selected power source.

Line Voltage Select Chart

VAC +-10%	100 120	220 240	50 to 400 Hz
Fuse	3/4 ATD	3/8 ATD	40 VA

2-10. CABLE CONNECTIONS.

2-11. Front panel connector:

INPUT. Analyzer Input HIGH and LOW BNC type connectors and chassis ground allow connection of external audio signals for analysis. The Input impedance is 100 k ohms either side to ground. The LOW terminal is connected to chassis ground in the non-floating mode.

2-12. Rear panel connectors:

MONITOR. The MONITOR BNC type output connector provides a scaled output of the input signal in the level measurement mode and a scaled output of the input signal with the fundamental removed in the distortion and SINAD measurement modes. The output impedance is 600 ohms.

X CLK. The X CLK BNC type input connector provides a means of connecting to an external 10 MHz counter reference. The external reference is automatically selected when a TTL level signal is present.

2-13. PRELIMINARY CHECK.

2-14. The preliminary check verifies that the Model 1130 is operational and should be performed before the instrument is placed into use. To perform the preliminary check, set the front panel LINE switch to ON. Wait several seconds then depress the LCL/INIT key. The FREQUENCY display will contain the instrument firmware number and the other displays will contain dashes for a period of about two seconds. The FREQUENCY display will then contain the [ ] message with the KYBD legend illuminated. The ANALYZER display will contain the [ ] message for one level measurement cycle. The initialize sequence resets all functions and operating modes of the Model 1130 to the initialized values and conditions listed in Table 2-1.

2-15. Program location 99 is a recall-only location which contains the initialize values. The operating conditions at the time the instrument power is interrupted are maintained in non-volatile memory and restored when power to the Model 1130 is resumed.

TABLE 2-1. INITIAL CONDITIONS.

Analyzer Group:	Frequency Group:	Bus/Prgm Group:
AC level function enabled AC level displayed in linear units Filters disabled Floating input mode disabled	KYBD legend illuminated Frequency function enabled Special functions 0, 10, 70, and 80 are selected RMS detector enabled	Address function is unchanged Program function is set to 99 Service-Request is cleared Bus status is unchanged

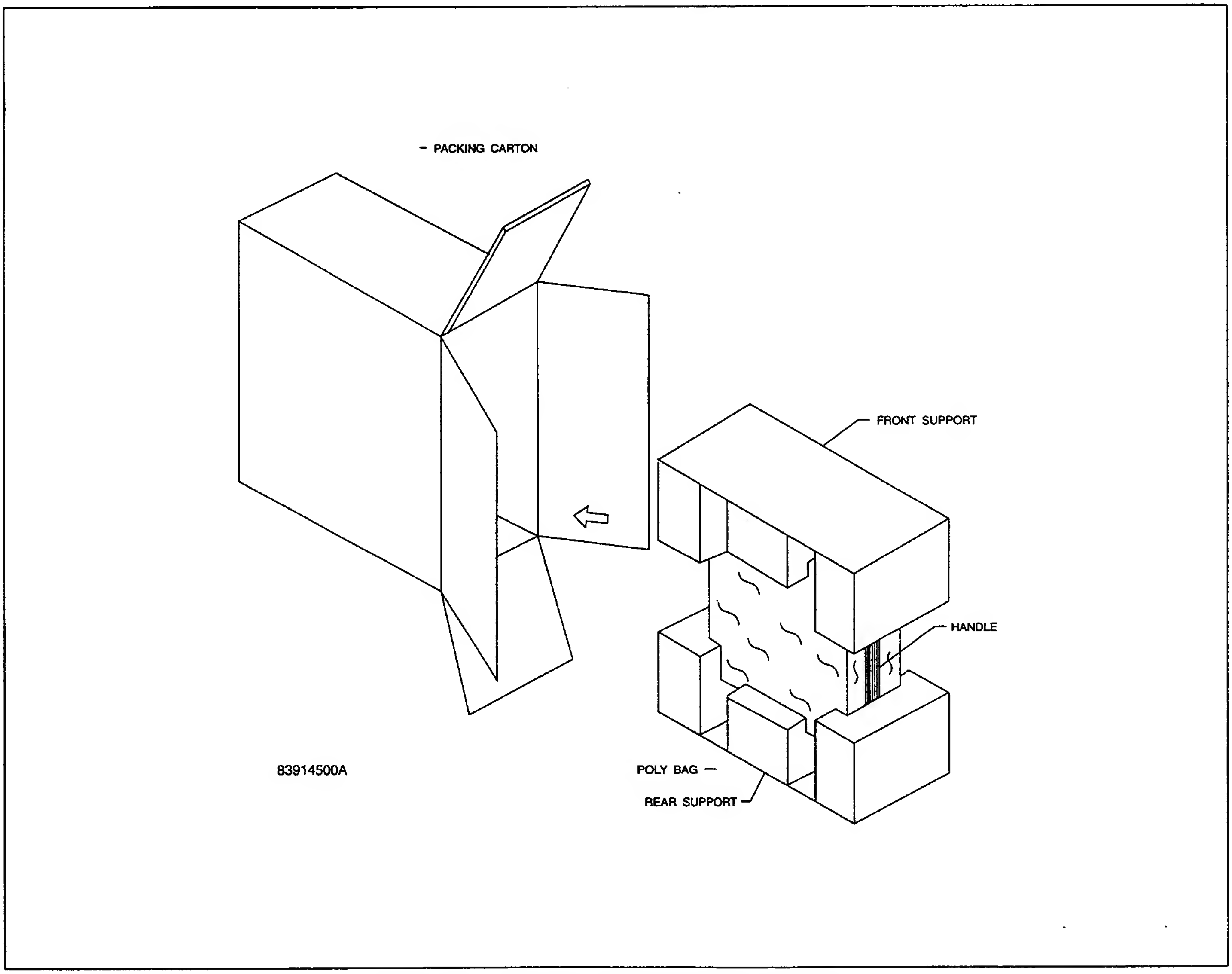


Figure 2-1. Packing and Unpacking Diagram.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section contains the operating instructions for the Model 1130 Distortion Analyzer.

3-3. OPERATING CONTROLS, INDICATORS AND CONNECTIONS.

3-4. The controls, indicators and connectors used during the operation of the instrument are listed in Table 3-1 and shown in Figures 3-1 and 3-2.

3-5. OPERATING INSTRUCTIONS.

3-6. The operating instructions for the Model 1130 are divided into sections of Initial Conditions, Local Operation and Remote Operation.

3-7. INITIAL CONDITIONS.

3-8. Initialize the instrument as follows:

a. Connect the power cord to the instrument and to the desired power source. Refer to paragraph 2-7 for proper power application.

b. Set the front panel power switch to ON.

c. Depress the LCL/INIT key.

d. The FREQUENCY display will contain the instrument firmware identification number and the other displays will contain dashes for a period of about two seconds. The FREQUENCY and ANALYZER displays will change to contain the [ ] message for one measurement cycle and the KYBD legend will be illuminated in the FREQUENCY display window.

3-9. LOCAL OPERATION.

3-10. **Function Selection.** The DATA ENTRY keypad is common to all functions of the Model 1130. The KYBD legend determines the active display window to which the DATA ENTRY keypad is dedicated at any given time. To select a function simply depress the function key desired. The results will be the LED of the function key will be illuminated, the current value of the selected function will be displayed in the window above the key, and the KYBD legend will be illuminated in the display window. The DATA ENTRY keypad is dedicated to the selected function and any unit selection or number entry will appear in the active display window. When selecting measurement functions the [ ] message may appear to indicate that a measurement cannot be displayed instantly for any of five possible reasons:

1. The first measurement cycle is in progress and cannot be displayed.

2. The measurements' minimum signal requirements are not met such as the input level is too low.

3. The input level is overrange.

4. The input signal is changing faster than the analyzer can respond.

5. The tune-status indicates the notch filter is not tuned. (tune-status can be ignored using special function 15)

3-11. **Data Entry Operation.** Once a function has been selected, new values may be entered with the DATA ENTRY keypad. To enter data simply depress the desired digit keys followed by the appropriate unit key or ENTER key. During digit selection a (') mark will appear in the display to the left of the first digit selected to indicate the number in the display is in the process of being entered. No action is taken until the unit or ENTER key is depressed. The unit keys can also be used aside from number entry to select display modes. For example, to change the level measurement displayed in mV to logarithmic units in dBV, simply select the analyzer LEVEL key and depress the dB key in the DATA ENTRY keypad. The display program will calculate and display the logarithmic value. The ENTER key serves a dual function as a dimensionless unit key for SPCL, ADRS, and PRGM number entry and also as a default unit terminator of V, %, and Hz for functions where more than one unit can be selected.

3-12. Many of the Model 1130 measurement functions have multiple display and entry modes. Listed in table 3-2, Function Display And Data Entry Units, are the display legends which can be active for each function along with the unit keys in the DATA ENTRY keypad which select the available display modes. Argument entry ranges for all the Model 1130 functions are described in Table 3-3, Valid Function Argument Range. Number entry out of range of the selected functions will result in an error displayed in the FREQUENCY display window. Errors can be cleared by depressing any key.

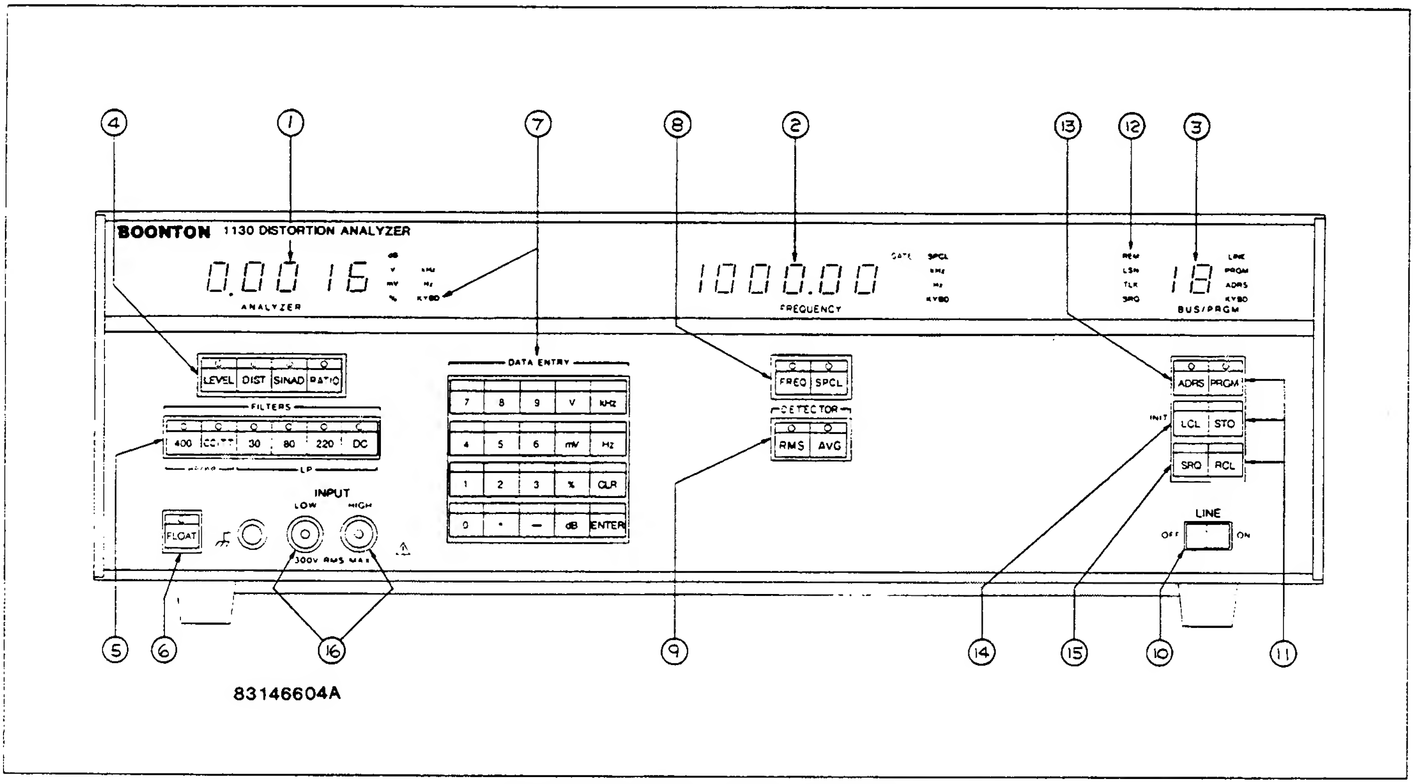


Figure 3-1. Model 1130, Front View.

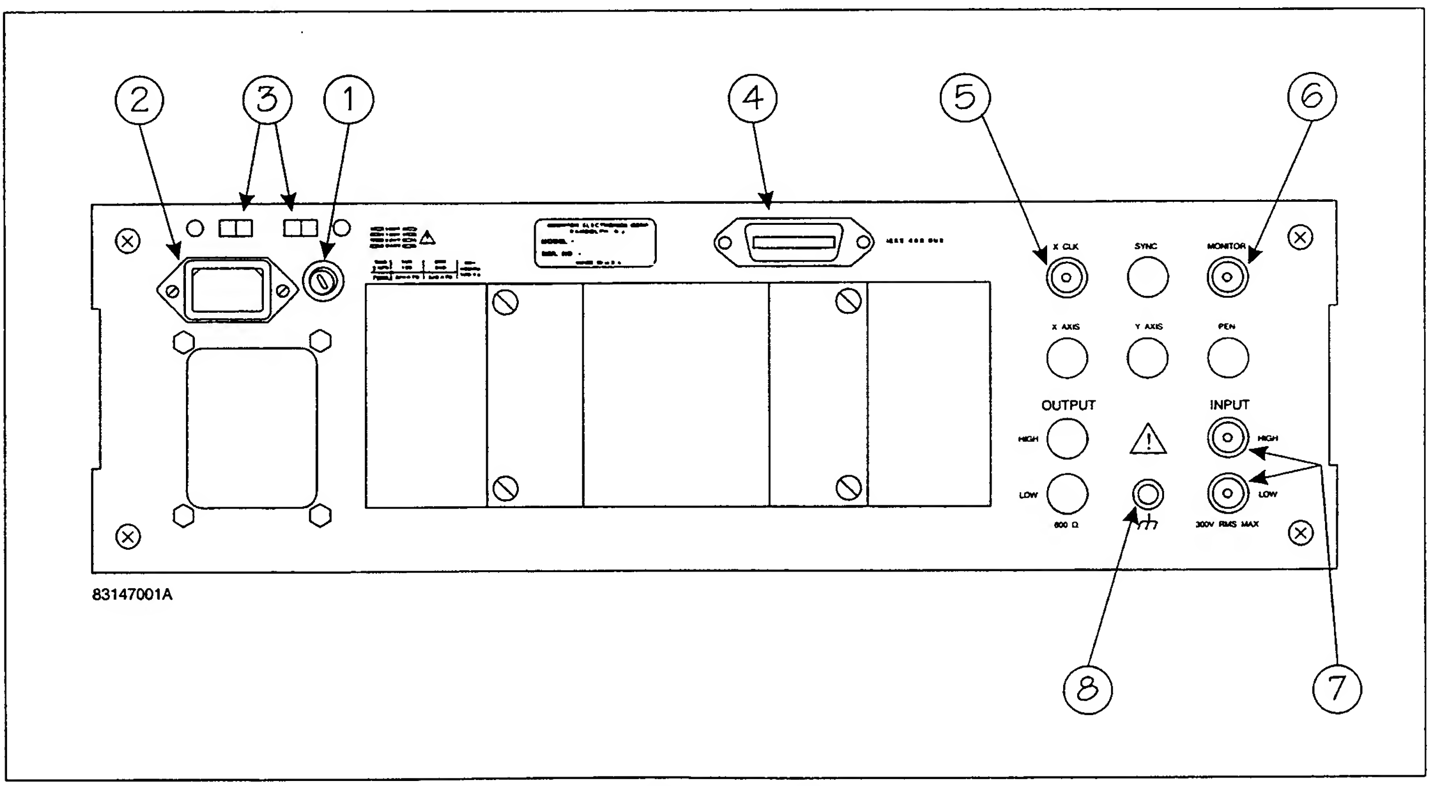


Figure 3-2. Model 1130, Rear View.

TABLE 3-1. CONTROLS, INDICATORS AND CONNECTORS.

Control, Indicator, or Connector	Figure and Index No.	Function
ANALYZER display	**3-1, 1**	Displays AC and DC level, distortion, SINAD, and ratio measurements. (6 digit LED display)
FREQUENCY display	**3-1, 2**	Displays special function or frequency measurement with gate indication. Alternately displays error codes and messages. (8 digit LED display)
BUS/PRGM display	**3-1, 3**	Displays current program number or IEEE-488 bus address. (2 digit LED display)
ANALYZER keys	**3-1, 4**	Selects the following active analyzer functions.
LEVEL key		Displayed in V, mV, dBV or dBm
DIST key		Displayed in %, dB, dBV, dBm, V, or mV. Notch tune frequency displayed in Hz or kHz. Notch capable of automatic or manual tuning.
SINAD key		Displayed in dB and the notch filter is manually tuned.
RATIO key		Displays ratios in % or dB.
FILTER keys	**3-1, 5**	Selects optional filters or 30 kHz, 80 kHz, or 220 kHz low-pass or DC level filters.
FLOAT key	**3-1, 6**	Selects floating or single-ended input connection.
DATA ENTRY keypad	**3-1, 7**	Used with the function keys to enter data into the active display designated by the KYBD annunciator.
FREQUENCY keys	**3-1, 8**	Selects the following active functions.
FREQ key		Displayed in Hz or kHz with GATE indication.
SPCL key		Allows alteration to the normal analyzer modes of operation such as: range hold, notch tune hold, slow responding detector, and special modes for testing, troubleshooting, and automatic calibration.
DETECTOR keys	**3-1, 9**	Selects the following AC measurement detectors.
RMS key		Allows selection of rms responding detector.
AVG key		Allows selection of average responding detector.
LINE switch	**3-1, 10**	Switches the instrument AC power on or off.

TABLE 3-1. CONTROLS, INDICATORS AND CONNECTORS CONTINUED.

Control, Indicator, or Connector	Figure and Index No.	Function
PROGRAM keys	3-1, 11	Selects the following program functions.
PRGM key		Allows display and entry of the store/recall program location.
STO key		Stores the instrument setup at the current program location.
RCL key		Recalls the instrument setup at the current program location.
Bus status	3-1, 12	Displays the current IEEE-488 bus status; REM (remote enabled), LSN (listener addressed), TLK (talker active), and SRQ (service request).
ADRS key	3-1, 13	Allows display and entry of IEEE-488 bus address.
LCL/INIT key	3-1, 14	Causes the instrument to "go-to-local" when remote enabled otherwise executes the initialize sequence.
SRQ key	3-1, 15	Sets the IEEE-488 bus SRQ line true.
INPUT connectors	3-1, 16	LOW and HIGH. Used to apply an external audio signal for analysis. The LOW terminal is connected to chassis ground in the non-floating mode.
Fuse holder	3-2, 1	AC line fuse holder.
AC connector	3-2, 2	AC power connector.
Line voltage selector switches	3-2, 3	Selects the desired operating voltage.
IEEE-488 connector	3-2, 4	Provides a means for connecting the standard IEEE-488 bus interface cable.
X CLK connector	3-2, 5	Provides a TTL compatible input for an external 10 MHz timebase reference. Automatic switching to external reference when present.
MONITOR connector	3-2, 6	In the level mode provides a scaled output of the input signal. In the distortion and SINAD modes: provides a scaled output of the input signal with the fundamental removed.
INPUT connectors	3-2, 7	Rear panel input connectors which replace the front panel input connectors.
Ground connector.	3-2, 8	Chassis ground connector.

If at any time prior to entry a wrong digit is entered, depress the CLR key to clear and restore the previous display.

3-13. Analyzer Measurement Description. The Model 1130 contains an independent distortion analyzer which can measure frequency, AC and DC level, distortion, and SINAD. In addition, ratio measurements can be made with all analyzer measurement modes except frequency. A wide range of special functions enhance the basic measurement modes without sacrificing the simplified operation of the analyzer. Standard and optional audio filters are provided to aid in harmonic distortion analysis and weighted noise measurements. Finally, the ability to store and recall specific measurement combinations aid in configuring measurement applications for manual and remote use.

3-14. Analyzer Input Description. The input configuration of the Model 1130 can be selected for single-ended or balanced/differential operation. The input mode can be enabled using the front panel FLOAT key or over the IEEE-488 bus interface.

3-15. Frequency Measurement Function. The Model 1130 measures wide ranges of audio frequency with high accuracy and resolution. Microprocessor control of the reciprocal counter results in automatic selection of frequency ranges for maximum resolution. Measurements are referenced to an internal 10 MHz timebase accurate to 0.0001 % and external reference capability is also provided.

3-16. Frequency Measurement Display Units. Frequency measurements can be displayed in Hz or kHz for values above 199.999 Hz with automatic selection of Hz units below this limit. To select the Frequency measurement function simply depress the FREQ key which illuminates both the key's LED and the KYBD legend in the FREQUENCY display. Display units can then be selected by depressing the Hz or kHz keys.

3-17. Special Frequency Measurement Modes. Special function 11 is provided to preset and hold specific level ranges for frequency measurement. Faster first measurement rates can be achieved in this manner. The frequency measurement mode can function to input levels 40 db below the selected level range. For example by setting the 3.000 volt level range, measurements can be made with signal levels as low as 30 mV.

3-18. Level Measurement Function. The Model 1130 measures both AC and DC voltage with high dynamic range and variable AC bandwidth. Resolution at full scale is 3000 counts with an additional 20 % overrange capability. The AC

TABLE 3-2. FUNCTION DISPLAY AND DATA ENTRY UNITS.

Function	Display Legends	Unit Keys	Default Units (ENTER Key)
ANALYZER GROUP:			
LEVEL	mV V dBV dBm	mV V dB	V
DIST	mV V Hz kHz % dB dBV dBm	mV V Hz kHz % dB	%
SINAD	dB	mV V dB	dB
RATIO	% dB	% dB	no entry
FREQUENCY GROUP:			
FREQ	Hz kHz	Hz kHz	no entry
SPCL	SPCL	ENTER	dimensionless
BUS/PRGM GROUP:			
ADRS	ADRS	ENTER	dimensionless
PRGM	PRGM	ENTER	dimensionless

TABLE 3-3. VALID FUNCTION ARGUMENT RANGE.

Function	Argument Range	Entry Action	Error No.
ANALYZER GROUP:			
LEVEL	0 mV to 300 V	Input level range	13
DIST	0 mV to 300 V 0 to 100 % -120 to 0.0 dB 5 Hz to 140 kHz	Input level range Distortion range (lin) Distortion range (log) Notch tune frequency	14 14 14 14
SINAD	0 mV to 300 V -120 to 0.0 dB 5 Hz to 140 kHz	Input level range SINAD range (log) Notch tune frequency	15 15 15
RATIO	no entry allowed		17
FREQUENCY GROUP:			
FREQ	no entry allowed		12
SPCL	See TABLE 3-6	See TABLE 3-6	05
BUS/PRGM GROUP:			
ADRS	0 to 30	IEEE-488 Bus Address	10
PRGM	0 to 99	Store/Recall Location	11

rms detector is true rms responding for signals with a crest factor of <3. An average responding detector (rms calibrated) can also be selected for AC measurement. A period sampling measurement technique is employed which results in variable measurement rates optimized by the period of the dominant AC component. This technique enables fast settled measurements in the AC level mode while rejecting large AC components in the DC level mode. Measurement bandwidth is selectable using the standard and optional filters to reject out-of-band noise or provide industry-standard weighting characteristics for noise measurements.

3-19. **Level Measurement Display Units.** AC and DC level measurements can be displayed in linear or logarithmic units. Linear measurements are displayed in mV or V with V automatically selected for levels above 750 mV and mV automatically selected for levels below 0.300 V. Logarithmic measurements are displayed in various forms. The default mode uses dBV units (dB relative to 1.000 V rms). Power in dBm units (dB relative to 1 mW) can be selected for various impedances as described in paragraph 3-42. To select the Level measurement function simply depress the LEVEL key which illuminates both the key's LED and the KYBD legend in the ANALYZER display. The various display modes can then be selected by depressing the appropriate units associated with the desired display mode. For example, to select AC level in logarithmic units depress the dB key and to return the display to linear units depress the mV or V keys.

3-20. **Special Level Measurement Modes.** Special function 11 is provided to preset and hold specific level ranges to achieve faster first measurement rates. Special function 17 extends the measurements sampling period to provide a more consistent reading in the presence of noise. AC and DC calibration is performed through the use of special function codes 20 through 24. The average or rms AC detector type can be selected using special functions 70 and 71. Special functions 80 through 86 select logarithmic display modes in dBV or dBm units.

3-21. **Distortion Measurement Function.** The Model 1130 measures total harmonic distortion and noise over a wide range of frequency. The notch filter is automatically tuned to reject the fundamental frequency and pass only the

harmonic and noise content. The AC measurement techniques are similar to those used in the level measurement function yielding fast settled measurements. Measurement bandwidth is selectable to reject noise while accurately preserving harmonic components. Measurement results can be displayed in several forms. The combination of harmonics and noise can be displayed as an absolute level in mV, V, dBV or dBm units or as a ratio in % or dB units to the total input signal consisting of fundamental, harmonics and noise.

3-22. Distortion Measurement Display Units. Distortion measurements can be displayed in linear or logarithmic units. Linear ratiometric measurements are displayed in % while logarithmic measurements are displayed in dB where 0.00 dB is referenced to 100.0 %. Distortion measuremnts can also be displayed as an absolute level in units of mV, V, dBV or dBm. The distortion level display mode is useful to measure noise level in the prescence of a holding tone. The holding tone is removed by the notch filter and the noise level alone is measured and displayed. In addition the frequency of the notch filter can be displayed in Hz or kHz units. To select the distortion measurement function simply depress the DIST key which illuminates both the key's LED and the KYBD legend in the ANALYZER display. The various display modes can then be selected by depressing the appropriate units associated with the desired display mode. For example, to select distortion level in logarithmic units (dBV or dBm) depress the DIST key followed in sequence by the mV or V keys and the dB key. The mV or V keys select the distortion measurement to be displayed as an absolute level and the dB key converts the results to logarithmic units.

3-23. Special Distortion Measurement Modes. Special functions 12 and 13 are provided to preset and hold specific input level and distortion ranges to achieve faster first measurement rates. Special function 17 extends the measurements sampling period to provide a more consistent reading in the presence of noise. Using special function 14, notch filter tuning can be held at specific frequencies to aid in tuning the notch filter in the event that a stable frequency measurement can not be achieved or to enable notch filter tuning to frequencies other than the fundamental. As with all amplitude measurement functions, the average or rms detector type can be selected using special functions 70 and 71. Special functions 80 through 86 select logarithmic distortion level display units in dBV or dBm.

3-24. SINAD Measurement Function. The Model 1130 measures SINAD (signal-to-noise and distortion) in the same manner as the distortion measurement except that the notch filter can only be manually tuned and held at a selected frequency to permit measurements in the presence of large amounts of noise. If an external oscillator is used, it must be tuned to within 3 % of the notch filter frequency setting. The AC measurement techniques are similar to those used in the level measurement function yielding fast settled measurements. Measurement bandwidth is selectable to reject noise while accurately preserving harmonic components. The combination of harmonics and noise are displayed as a percentage of the total input signal consisting of fundamental, harmonics and noise.

3-25. SINAD Measurement Display Units. SINAD measurements are only displayed in dB units. To select the SINAD measurement function simply depress the SINAD key which illuminates both the key's LED and the KYBD legend in the ANALYZER display.

3-26. Special SINAD Measurement Modes. Special functions 12 and 13 are provided to preset and hold specific input level and SINAD ranges to achieve faster first measurement rates. Special function 17 extends the measurements sampling period to provide more consistent readings in the presence of noise. When measuring large amounts of SINAD, the tune-status line becomes unreliable and causes the [ ] message to be displayed. Special function 15 will ignore the internal notch filter tune-status information. As with all amplitude measurement functions, the average or rms detector type can be selected using special functions 70 and 71.

3-27. Using the Ratio Mode. The Model 1130 enables level, distortion and SINAD measurement modes to be displayed as a relative value to a previous measurement value. In a ratiometric measurement, such as a flatness response, amplitude measurements at various frequencies are displayed relative to a reference level at a frequency of 1 kHz. Other possible ratiometric measurements include direct display of the percent of AC ripple on a DC level.

3-28. Ratio Measurement Display Units. Ratiometric level measurements are displayed in % or dB units. To select the ratio mode simply depress an analyzer measurement key such as LEVEL followed by the RATIO key. The LEDs of both keys will be illuminated along with the KYBD legend in the ANALYZER display. When the next measurement cycle is complete, the measurement value will become the ratio reference and the display will indicate 100.00 % or 0.00 dB depending on the previous log/linear display mode. Selection of display units can be made by depressing either the % or dB keys. On subsequent measurement cycles the results will be displayed relative to the original ratio reference. The RATIO key is an alternate action key, therefore, depressing the RATIO key again will deselect the ratio mode, extinguish the key's LED and return the display to the normal measurement mode. If another measurement function is selected while the ratio mode is active, the LED on the RATIO key will be extinguished but the ratio reference is preserved for the original measurement function and can be reactivated by depressing the original measurement function key. The ratio mode is limited to only one reference value and the old ratio

TABLE 3-4. INPUT LEVEL RANGES.

AC Level Ranges:	DC Level Ranges:	Distortion and SINAD Input Level Ranges
300.0 to 150.1 V	300.0 to 150.1 V	300.0 to 150.1 V
150.0 to 75.01 V	150.0 to 75.01 V	150.0 to 75.01 V
75.00 to 30.01 V	75.00 to 30.01 V	75.00 to 30.01 V
30.00 to 15.01 V	30.00 to 15.01 V	30.00 to 15.01 V
15.00 to 7.501 V	15.00 to 7.501 V	15.00 to 7.501 V
7.500 to 3.001 V	7.500 to 3.001 V	7.500 to 3.001 V
3.000 to 1.501 V	3.000 to 1.501 V	3.000 to 1.501 V
1500 to 750.1 mV	1.500 to 0 mV	1500 to 750.1 mV
750.0 to 300.1 mV		750.0 to 300.1 mV
300.0 to 150.1 mV		300.0 to 150.1 mV
150.0 to 75.01 mV		150.0 to 100.1 mV
75.00 to 30.01 mV		100.0 to 0 mV
30.00 to 15.01 mV		
15.00 to 7.501 mV		
7.500 to 3.001 mV		
3.000 to 0 mV		

reference is lost if the ratio mode is activated in an alternate measurement function.

3-29. **Using Analyzer Filters.** The Model 1130 is equipped with low-pass and optional filters. The filter selection is determined by the type of measurement to be made. The minimum bandwidth consistent with the measurement bandwidth should be used to minimize noise errors. For example, when measuring the distortion of a 1 kHz fundamental tone, the 30 kHz low-pass filter is recommended. The DC low-pass filter is provided to attenuate all AC components and measure DC level directly. The DC low-pass filter can only be activated in the analyzer level mode. Band-pass filters are combinations of high and low-pass filters and are used in some measurements to simulate the sensitivity of the human ear to the audible frequency spectrum. High-pass filter selection is used to eliminate power line harmonics when present. The 400 Hz high-pass filter typically provides more than 80 dB of attenuation at 60 Hz. The audio filter keys are alternate action keys. The audio filters are only used in level related measurements and have no effect on the bandwidth of the frequency measurement mode. The optional filters are mutually exclusive; therefore, depressing one of the keys will cancel the other. The same is true of the low-pass filters, only one low-pass filter can be used at a time. The DC filter, however, is mutually exclusive with all filters and will also be canceled by selecting any measurement functions other than Level.

3-30. **Program Store And Recall Description.** The entire status of the Model 1130, including all functions, entered values and display modes, can be saved in a program location of non-volatile memory for recall at a later time. Up to 99 such programs (0-98) can be stored and recalled.

3-31. **Store Operation.** To save the complete front-panel setup in the program memory, first set all the desired instrument operating parameters to be stored. Next depress the PRGM key and enter the desired program location with the DATA ENTRY keypad and the ENTER key. Finally, depress the STO key to save the complete instrument status in program memory. Below is a list of all the parameters which are retained in program memory.

1. All entered values of all functions.

2. All selected analyzer functions.

3. All filter and floating settings.

4. All display modes and selected display units.

TABLE 3-5. DISTORTION AND SINAD RANGES.

Linear:	Logarithmic:
100.0 to 50.01 %	0.00 to -6.01 dB
50.00 to 20.01 %	-6.02 to -13.97 dB
20.00 to 10.01 %	-13.98 to -19.99 dB
10.00 to 5.001 %	-20.00 to -26.01 dB
5.000 to 2.001 %	-26.02 to -33.97 dB
2.000 to 1.001 %	-33.98 to -39.99 dB
1.000 to .5001 %	-40.00 to -46.01 dB
.5000 to .2001 %	-46.02 to -53.97 dB
.2000 to .1001 %	-53.98 to -59.99 dB
.1000 to 0 %	-60.00 to -120.00 dB

5. Ratio mode reference and ratio status.

6. All special functions settings

7. All analyzer range and tune settings.

3-32. **Recall Operation.** To recall the front-panel setup in the program memory, depress the PRGM key and enter the desired program location with the DATA ENTRY keypad and the ENTER key. After the memory location has been selected, depress the RCL key. The ANALYZER and FREQUENCY displays will indicate the [ ] message until the next measurement cycle is complete. Program location 99 is a recall-only location that restores the initialize parameters in the same manner as the LCL/INIT key. Any panel setting may be changed after recalling a program location.

3-33. **Program Memory Initialization.** In normal use the internal memory is never erased, new programs are simply written over the old ones. It is necessary, however, to erase the program memory after a new firmware revision has been installed or after the CPU circuit board has been serviced. Entering Special Function 25 will erase the entire program memory. Attempting to recall an erased program will result in Error 11 being displayed. Special function 25 can be disabled using the internal Option switch A4S1-4.

3-34. **Special Function Description.** The Model 1130 provides special modes of operation for specific measurement situations. Special function modes shown in Table 3-6 can be selected using the SPCL key and the DATA ENTRY keypad.

3-35. **Option Switch functions.** Codes 1 through 8 supersede current settings of the internal Option switch, A4S1. The Option switch settings are restored on power-up, by executing special function 0, or by depressing the LCL/INIT key.

3-36. **Mode Alteration functions.** Codes 11 through 19 alter the normal operation of the analyzer. When selected, the SPCL legend in the FREQUENCY display window will remain illuminated as an indication of the special operating mode regardless of the function displayed.

3-37. The range-hold functions, 11 through 13, affect the analyzer measurements by defeating the autorange capability. The current level or distortion range can be held at its present value by entering the appropriate special function code. Other ranges can be set and held by selecting the desired analyzer measurement mode and entering the level or distortion range directly into the ANALYZER display window using the DATA ENTRY keypad. Available level and distortion ranges for all analyzer measurement modes are listed in Table 3-4. It is not necessary to enter the exact full scale value to set a range, rather the value need only fall within the desired range. When a range is selected the appropriate special code will automatically be activated and the SPCL legend will be illuminated. Range-hold mode is cleared by selecting an alternate analyzer function, using special function 10 or initializing the instrument.

3-38. The notch-hold and ignore-tune-status functions, 14 and 15, affect the analyzer distortion and SINAD measurement modes by defeating the auto-tune capability in the distortion mode and disabling the tune-status information in the SINAD mode. Tune-status information is unreliable in the presence of very high SINAD readings resulting in the [ ] message being displayed. Independent notch tuning enables the distortion mode circuits to function as a programmable notch filter to attenuate selected tones other than the fun-

damental. These special modes can be activated by entering the special code or by selecting the analyzer distortion mode and entering the notch frequency directly into the ANALYZER display window using the DATA ENTRY keypad. Direct entry of the notch frequency will automatically select Special 14 and the SPCL legend will be illuminated. Notch-hold and ignore-tune-status modes are cleared by using special function 10 or initializing the instrument.

3-39. The slow detector function, 17, is provided to extend the level measurement sampling time to provide more consistent readings in the presence of noise. The level measurement employs a period sampling technique which adjusts the measurement period to include the period of the dominant AC signal. This process is extended to include low frequency components which cause inconsistent readings. The slow detector mode is cleared by using special function 10 or initializing the instrument.

3-40. **Calibration And Test Functions.** Codes 20 through 39 are used in calibration, testing and troubleshooting of the Model 1130. These functions can be disabled using Option switch A4S1-4 to prevent accidental use resulting in possible loss of current calibration and memory data.

3-41. **AC Detector Selection Functions.** Codes 70 and 71 are used as an alternate mode for selection of the AC detector type. These functions perform the same action as the front panel RMS and AVG detector keys. The default mode after initialization is the rms detector, code 70.

3-42. **dBV/dBm Display Mode Functions.** Codes 80 through 86 are used to select the reference used to calculate the logarithmic display value. All logarithmic level measurements will be displayed in the form selected. The default mode after initialization is code 80, dBV.

3-43. **Option Switch, A4S1, Operation.** Several of the Model 1130 operating features are internally programmable by setting bit switch A4S1. Gaining access to the switch requires that the cover be removed. Some of the option switch functions can be altered using the special functions 1 through 8. The option switch consists of eight separate switches which change the operating conditions of the Model 1130. Table 3-7 list the individual switches and their function.

3-44. Positions 1 and 2 of A4S1 are used for end-of-string (EOS) control for the IEEE-488 bus. End-or-Identify (EOI) is always recognized and asserted in addition to the EOS characters selected. Position 4 is available to restrict the use of Special Functions 20 through 39. These Special Functions are associated with calibration and repair of the instrument. Position 5 determines the operation of the IEEE-488 SRQ function. When enabled the SRQ line will be set true if the SRQ key is depressed or if the instrument is in the remote condition and an error is generated. Position 7 and 8 are used for test modes and optional filter installation. When the lamp test is selected the display LEDs, display legends, and key LEDs with the exception of the ANALYZER and FREQUENCY function keys will be constantly illuminated. The remaining function keys will be illuminated in sequence.

3-45. **Error Codes.** Error codes and descriptions for the Model 1130 are listed in Table 3-8. The error codes will appear in the FREQUENCY display window and will be returned by the talk-status (TS) IEEE-488 bus function if executed. The SRQ status byte will consist of the error code expressed in excess sixty-four. The status code 64 decimal means the SRQ was activated by the front panel SRQ key rather than an error.

3-46. REMOTE OPERATION.

3-47. Any front-panel operation of the instrument with the exception of the POWER ON/OFF switch and the address function can be remotely controlled under direction of an IEEE-488 interface controller.

3-48. **Setting the Bus Address.** To set the IEEE-488 bus address (MLTA), depress the ADRS key, enter the address number by means of the DATA ENTRY keypad and use the ENTER key to complete the entry. The address may be any decimal number from 0 to 30, inclusive. A secondary address is not implemented.

3-49. **Entering the Remote Mode.** The instrument is put in the remote mode by addressing it as a listener with remote enable (REN) true. In the remote state the keyboard is disabled, except for the LCL/INIT key and the POWER ON/OFF switch, and the REM status annunciator is illuminated.

3-50. **Returning to Local Mode.** The instrument may be returned to the local mode as follows:

a. The LCL/INIT key is depressed, provided local lockout (LLO) is not active.

b. The go-to-local (GTL) bus command is sent.

c. Remote enable (REN) is set false.

NOTE

The instrument must be placed in the remote mode for it to store and respond to data messages.

3-51. **Triggered Operation.** In the remote mode the instrument can be operated in the immediate mode (mnemonic IM), or in the wait-for-trigger mode (WT). The immediate

TABLE 3-6. SPECIAL FUNCTIONS.

Option Switch A4S1 Functions:

0	Option Switch: Restores current settings		
1	EOS Character:	Listen: LF or CR LF	Talk: CR LF
2	EOS Character:	Listen: CR	Talk: CR LF
3	EOS Character:	Listen: CR	Talk: CR
4	EOS Character:	Listen: CR	Talk: CR

Mode Alteration Functions:

10	Clear functions 11 through 19.
11	Range Hold: input voltage range and post notch detector range.
12	Range Hold: input voltage range only.
13	Range Hold: post notch detector range only.
14	Notch Hold: hold notch frequency tuning at preset frequency in distortion mode.
15	Ignore Tune Status: display SINAD measurements without regard to tune-status informaton.
17	Slow Detector: noise rejecting filter response.

Automatic Calibration And Test Functions:

(These functions can be disabled using Option Switch A4S1-4)

20	Auto Cal AC Level
21	Auto Cal Optional Filter No. 1
22	Auto Cal Optional Filter No. 2
23	Auto Cal DC Offset
24	Auto Cal DC Level
25	Erase all program memory locations
26	300 Volt range - special calibration mode
27	30 Volt range - special calibration mode
28	3 Volt range - special calibration mode
31	Counter plug-in board test mode
32	Input plug-in board test mode
33	Filter plug-in board test mode
34	Notch and Detector plug-in board test mode

AC Detector Selection Functions:

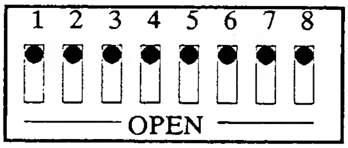
70	RMS detector enabled
71	Average detector enabled

dBV/dBm Display Mode Selection Functions:

80	dBV display mode referenced to 1.000 V
81	dBm display mode referenced to 1 mW, 50 ohms
82	dBm display mode referenced to 1 mW, 75 ohms
83	dBm display mode referenced to 1 mW, 150 ohms
84	dBm display mode referenced to 1 mW, 300 ohms
85	dBm display mode referenced to 1 mW, 600 ohms
86	dBm display mode referenced to 1 mW, 900 ohms

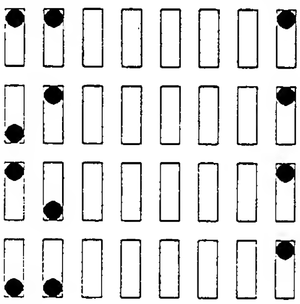
TABLE 3-7. OPTION SWITCH A4S1.

Normal Setting:



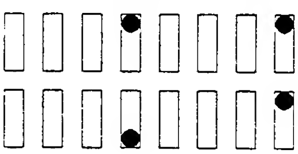
Factory settings.

EOS Character Selection:



Listen: LF or CR LF	Talk: CR LF
Listen: CR	Talk: CR LF
Listen: CR	Talk: CR
Listen: CR	Talk: LF

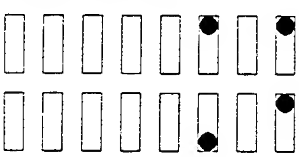
SPCL Function Disable:



Enable SPCL Functions 20 through 39

Disable SPCL Functions 20 through 39

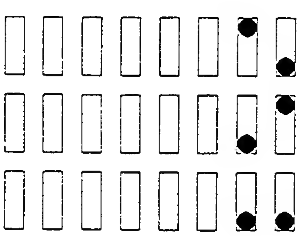
SRQ Enable:



Disable SRQ

Enable SRQ

Test Mode Enable:



Lamp Test

Filter Option Entry Mode

Reference Test

 OPEN  CLOSED  IRRELEVANT

TABLE 3-8. ERROR CODES.

Error Code	Description
05	Illegal special function entry
10	Bus address entry out of range
11	Store/Recall error: attempting to recall an erased location or Store in read-only location No. 99
12	Frequency error: attempting to set an illegal voltage range or any frequency entry
13	Level error: attempting to set an illegal input voltage range
14	Distortion error: attempting to set an illegal input range, notch frequency, or distortion range
15	SINAD error: attempting to set an illegal input range, notch frequency, or SINAD range
17	Ratio error: attempting to enter an analyzer setting while in the ratio mode
18	Ratio error: ratio display overrange
19	Ratio error: unable to enter ratio mode while displaying notch tune frequency
20	Illegal units for active function
21	Buffer overflow: too many key entries for display or IEEE-488 buffer overflow
22	IEEE-488 bus error: non existent mnemonic
23	IEEE-488 bus error: illegal Learn string format
40	Auto cal error: post notch rms detector
41	Auto cal error: post notch average detector
42	Auto cal error: input rms detector
43	Auto cal error: DC detector full scale
45	Auto cal error: option filter No. 1
46	Auto cal error: DC detector offset
47	Auto cal error: option filter No. 2

mode is the default condition and results in the immediate response to mnemonic commands and settings. The wait-for-trigger mode causes the execution of commands and settings to be deferred until a trigger is received. This aids in synchronizing the instrument's state changes to other system components. The wait-for-trigger mode is set when the WT mnemonic is encountered in the input string. From that point on execution is delayed. No change will occur until one of the following events is encountered:

a. "Group-execute-trigger" (GET) is received.

b. The mnemonic TR (trigger) is interpreted.

c. Any mnemonic following IM (immediate) is interpreted.

NOTE

Event (c), above, or go-to-local terminates the wait-for-trigger mode and restores the immediate mode. The wait-for-trigger mode is not active in local operation.

3-52. Talk Operation. The instrument may be addressed as a talker without regard for remote/local mode. When the talker state is set by the bus controller, the instrument sends a character string which is determined by the current talk mode. One of five different talk modes is selected by sending the appropriate mnemonic with the Model 1130 addressed as a listener. The selected mode will remain in effect until changed.

3-53. Talk Status (TS) Mode. In the TS mode the error code status of the instrument is returned as a number. Normal status returns a 0 code otherwise the error number is returned. The TS mode will automatically clear the error after the status is reported. The TS mode is the default talk mode after initialization of the instrument.

3-54. Talk Value (TV) Mode. In the TV mode the argument of the active function designated by the KYBD annunciator is returned as a number. All values returned are in basic units such as: Hz, V, %, dB, etc.

3-55. Talk Program (TP) Mode. In the TP mode a 10 digit number is returned that uniquely identifies the firmware and installed optional filters. A radix separates the firmware date code and the optional filter identification number. The 4 digit code to the right of the radix will correspond to codes listed in Table 5-2.

3-56. Talk Function (TF) Mode. In the TF mode a variable length string of ASCII characters will be returned which identifies the state of all active functions. The bit assignments are arranged to allow for string or byte oriented decoding. The various characters are listed in Table 3-10.

3-57. Talk Learn (TL) Mode. In the TL mode a compressed parameter string of 143 ASCII characters, the last of which is an ASCII ($), is returned. This string can be sent back to the instrument to restore the exact state of all functions and settings which defined it, but it must be sent as a complete string without alteration. When the ($) character is encountered in the input buffer, the learn mode is automatically activated. While this form provides a compact and fast method to save and restore all settings, it bypasses much of the error control and therefore must be used with caution.

3-58. End-Of-String (EOS) Control. The instrument provides several end-of-string options to accommodate a wide variety of controllers. The instrument always terminates on EOI (end-or-identify) true and always sends EOI true with the last character of every string. In addition, CR, LF, or CRLF may be used. The use of CR and LF is selected by option switch A4S1-1 and 2 and special functions 1 through 4. Detection of EOI is not affected by A4S1 switch settings.

3-59. Using "Service Request" (SRQ). The instrument may be configured to set SRQ true when it is in the remote mode and an error occurs. This is enabled by setting the option switch A4S1-6 to the open position. The bus controller must be programmed to respond to SRQ true. In the usual case, the controller then executes a serial poll to determine which device caused SRQ to be true. If the instrument is the requesting device, it will respond to the serial poll with a single byte which expresses the error code number in excess sixty-four. The serial poll will clear the SRQ line automatically. In small systems only one instrument may be capable of using SRQ. In this situation there is no need to execute a serial poll since the identity of the requesting device is known. The error code may be obtained directly from the talk status (TS) mode. The SRQ line can then be cleared by sending the clear (CL) command.

3-60. Bus Command Responses. IEEE-488 bus commands are sent by the controller to all devices on the bus (Universal Command Group) or to addressed devices only (Addressed Command Group). The response of the instrument is listed in Table 3-11.

3-61. Program Function Mnemonics. Each front panel key is assigned a program mnemonic. Programming the mnemonic, followed by unit values, if appropriate, is analogous to manual front-panel operation. In addition, other program mnemonics are used for functions that are applicable only in remote operation. Table 3-9 lists all the program function mnemonics.

3-62. Number Formatting. Number formatting rules are as follows:

a. Fixed or floating formats are accepted.

b. The optional + or - sign may precede the mantissa and/or the exponent.

c. The optional radix point may appear at any position within the mantissa. A radix point in the exponent is ignored.

d. The optional "E" for exponent may be upper or lower case.

e. ASCII characters having hexadecimal values of 0 to 23 and 25 to 2C are ignored.

3-63. Data String Format. Data string formats are as follows:

a. The programming sequence is in natural order, that is, a function mnemonic is sent first followed by the argument, if appropriate.

b. ASCII characters having hexadecimal values of 0 to 23 and 25 to 2C are ignored. The ASCII ($), hexadecimal 24, is reserved. Lower case letters are automatically changed to upper case.

c. A primary function mnemonic sent without a following argument will make the specified function active.

d. The data string may not exceed 150 characters and may be terminated with LF, CR, and/or EOI.

3-53. Talk Status (TS) Mode. In the TS mode the error code status of the instrument is returned as a number. Normal status returns a 0 code otherwise the error number is returned. The TS mode will automatically clear the error after the status is reported. The TS mode is the default talk mode after initialization of the instrument.

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b. ASCII characters having hexadecimal values of 0 to 23 and 25 to 2C are ignored. The ASCII ($), hexadecimal 24, is reserved. Lower case letters are automatically changed to upper case.

c. A primary function mnemonic sent without a following argument will make the specified function active.

d. The data string may not exceed 150 characters and may be terminated with LF, CR, and/or EOI.

e. Interpretation of the data string does not begin until termination occurs.

f. If units are unspecified for any argument, default units are automatically appended. The functions SPCL and PRGM always use default units.

g. If a unit mnemonic is sent without a corresponding argument, the display will reflect the change provided that the units are appropriate for the active function and the display can accommodate the rescaled number.

3-64. Data String Errors. Errors are detected during interpretation. The occurrence of an error will display the error code if the display is enabled, and will set SRQ true, if enabled. The error and SRQ can be cleared by a serial poll, a status request (TS), or a clear error instruction (CL). All errors cause previous valid parameters to be restored. No new input can be processed until an existing error is cleared.

3-65. Data String Examples. The following are examples of typical programming strings in HP BASIC:

OUTPUT 715; "SP17AVALDB"

TABLE 3-9. IEEE-488 BUS MNEMONICS.

Analyzer Function Group:	
AL	Analyzer level
DN	Distortion
SI	SINAD
RA	Enable ratio mode
RO	Disable ratio mode
Frequency Function Group:	
AF	Analyzer frequency
SP	Special function
Program Function Group:	
PG	Program location
RE	Recall program
ST	Store program
Units Group:	
HZ	Hertz
KH	Kilo Hertz
VO	Volt
MV	Millivolt
PC	Percent
DB	Decibel
Float Group:	
SA	Single-ended analyzer input
FA	Floating analyzer input
Detector Group:	
RM	Enable rms detector
AV	Enable average detector
Filter Group:	
F0	Disable both optional filters
F1	Enable optional filter No. 1 (left)
F2	Enable optional filter No. 2 (right)
L0	Disable all low-pass filters
L1	Enable 30 kHz low-pass filter
L2	Enable 80 kHz low-pass filter
L3	Enable 220 kHz low-pass filter
L4	Enable DC low-pass filter(AC rejection)
Talk Mode Group:	
TS	Talk status
TV	Talk value
TF	Talk function
TL	Talk learn string
TP	Talk program revision
Trigger Group:	
IM	Immediate mode
WT	Wait-for-trigger mode
TR	Trigger
Display Mode Group:	
BL	Blank display
UD	Update display
Error and SRQ Group:	
CL	Clear error
EI	Enable SRQ interrupt
DI	Disable SRQ interrupt

TABLE 3-10. TALK FUNCTION (TF) DECODING.

Talk Function String Format: 99,999,999,999,AAAAAAAAAAAA

Active Function Assignments:

5	Special Function
10	Bus Address
11	Program Number
12	Analyzer Frequency
13	Analyzer Level
14	Distortion
15	SINAD

Filter And Floating Bit Assignments:

[8]MSB	Float Analyzer Input
[7]	Optional Filter No. 1
[6]	not used
[5]	Optional Filter No. 2
[4]	DC low-pass filter
[3]	30 kHz low-pass filter
[2]	220 kHz low-pass filter
[1]LSB	80 kHz low-pass filter

Special Mode Bit Assignments:

[8]MSB	Notch-tune Hold
[7]	Input Range Hold
[6]	Ignore Tune-status
[5]	Not Used
[4]	Not Used
[3]	Post Notch Range Hold
[2]	Slow Detector
[1]LSB	Not Used

Option Switch Bit Assignments:

[8]MSB	A4S1-8	Lamp Test
[7]	A4S1-7	Not Used
[6]	A4S1-6	Enable SRQ
[5]	A4S1-5	Not Used
[4]	A4S1-1	End-of-String Character Select
[3]	A4S1-2	End-of-String Character Select
[2]	A4S1-3	Not Used
[1]LSB	A4S1-4	Disable Special Functions 20-39

Alternate Operating Modes:

[A]	Boxes currently displayed in ANALYZER window
[F]	Boxes currently displayed in FREQUENCY window
RA	Ratio mode
XC	External counter reference
RM	rms detector enabled
AV	Average detector enabled

TABLE 3-11. BUS COMMAND RESPONSES.

Commands	Instrument Response
Universal Command Group:	
Device Clear (DCL)	Clear errors
Local Lockout (LLO)	Disable LCL/INIT key
Serial Poll Enable (SPE)	Sets talk mode for poll response
Serial Poll Disable (SPD)	Restores talk mode before poll
Addressed Command Group:	
Selective Device Clear (SDC)	Same as device clear (DCL)
Go to Local (GTL)	Sets LOCAL mode
Group Execute Trigger (GET)	Triggers a measurement
All Others:	Ignored

OUTPUT 715; "RAPCF1"

OUTPUT 715; "PG1RE"

OUTPUT 715; "SI1.234KHDB"

3-66. **Store and Recall Operation.** Store and Recall operation may be used to advantage with a bus controller. The instrument provides either temporary or long-term storage for control strings. This can be used to minimize bus traffic by storing several control setups at initialization and recalling them when needed with a simple string statements, such as:

OUTPUT 715; "PG23RE"

Since few controllers have power fail protection, the data in the instrument's non-volatile memory is the more secure.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 1130 is a versatile, solid-state, microprocessor controlled, distortion analyzer that covers the frequency range of 10 Hz to 100 kHz. The instrument contains a fully automatic audio analyzer for manual and remote controlled testing. Function parameters can be keyed in through a front panel keyboard or with remote programming using the IEEE-488 interface. Selected modes and values are displayed on an alphanumeric display and LED indicators. Input commands are processed by the internal microprocessor and control signals are developed to set up the internal circuits in accordance with the commands. The use of the microprocessor also enables the storage of up to 99 complete sets of instrument setup data. Commonly used setups can be entered into non-volatile memory either through the keyboard or through the IEEE-488 interface; thereafter, the instrument can be set to any desired set of conditions in memory by keying in the code number assigned to the desired setup in storage.

4-3. FUNCTIONAL BLOCK DIAGRAM.

4-4. Control of the instrument operation is exercised by a microprocessor that executes a fixed program resident in read-only-memory (ROM). Timing of the microprocessor operations is controlled by a 5 MHz clock. A random-access-memory (RAM) provides storage capability for microprocessor data. To insure retention of data in storage, the non-volatile RAM is powered from an internal 3 volt lithium battery. The main power supply develops the operating power required by the instrument.

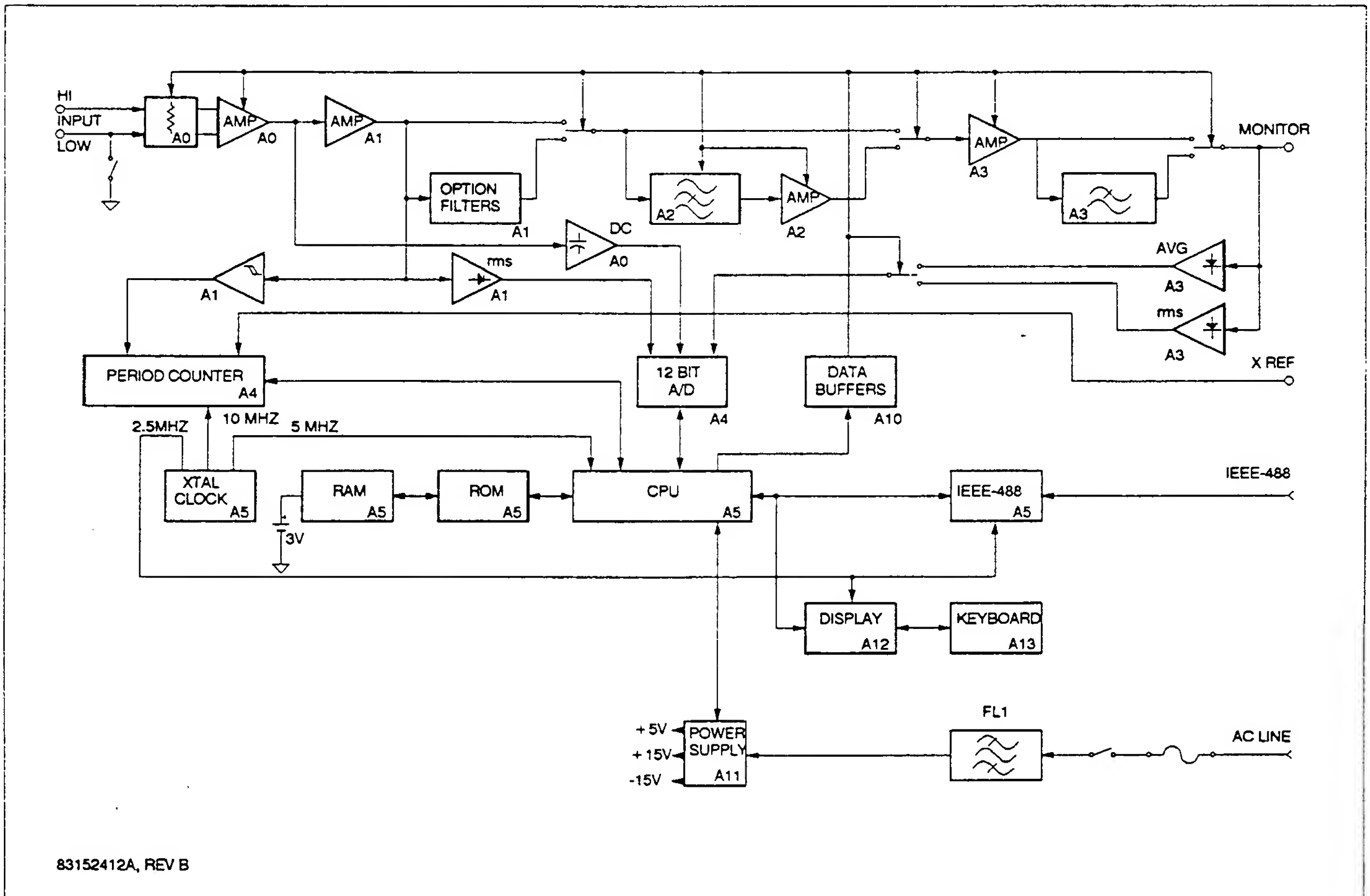

Figure 4-1. Functional Block Diagram.

4-5. The microprocessor communicates with the internal circuits through a data bus and an address bus. Command information is entered into the microprocessor through the front panel keyboard or an IEEE-488 interface. DIP switches are provided for option and test purposes. Input data selection is displayed by means of a digital readout and LED indicators. The microprocessor stores and processes input data, and generates data and address information to cause execution of command functions.

4-6. The audio input signal is first applied to a pair of differential attenuators followed by an instrumentation amplifier. The combination of amplification and attenuation normalizes a 300 mV to 300 V input level range to 1.2 to 3 volts. The DC component of the input signal is detected after the amplifier and measured with one channel of the analog-to-digital converter (A/D) and used for the DC level measurement mode.

4-7. The AC component of the input signal is AC coupled and amplified further by factors of either 1, 2, or 5. A squaring circuit is used to convert the AC waveform to a TTL compatible signal which is used for the frequency measurement mode. The rms level of the AC waveform is converted to DC and measured with another channel of the A/D converter. The level measurement at this stage is used to autorange the input attenuators and amplifiers and is also used in the calculation of the distortion and SINAD measurements. After the rms detector, connectors are provided for up to two optional filters which can be selected individually and inserted into the signal path.

4-8. A programmable notch filter tuned to the fundamental frequency is inserted into the signal path in the distortion and SINAD measurement modes. The notch filter is tuned by the microprocessor circuits based on a manually selected or measured fundamental frequency. An amplifier with gain factors of X1 or X10 follows the notch filter. The notch filter and associated amplifier are bypassed in the AC and DC level measurement modes.

4-9. A programmable gain amplifier follows the notch filter circuits and provides amplification over a range of X1 to X100 in X1, X2, or X5 increments. The amplifier is used in conjunction with the input amplifier in the AC level measurement mode to provide extended range from 300 mV down to 3 mV full scale. In the distortion and SINAD measurement modes the amplifier is used in conjunction with the notch amplifier to boost harmonic and noise content in the pass band of the notch filter by up to 1000X. Low-pass filter selections are provided after the amplifier to attenuate out-of-band noise and preserve significant harmonic components. Following the low-pass filters are two level detectors. The rms or average (rms calibrated) level of the AC waveform is converted to DC and measured with another channel of the A/D converter. The level measurement at this stage is used to autorange the post-notch detector amplifiers and is also used in the AC level, distortion, and SINAD measurement modes. The signal at the AC detectors is buffered and presented at the rear panel MONITOR output for external analysis.

4-10. The period counter circuits enable the Model 1130 to measure the fundamental frequency of the input signal for the frequency measurement mode and for automatic tuning of the notch filter.

4-11. The power supply circuits convert the incoming line voltage into regulated DC operating voltages to power the instrument circuitry.

4-12. DETAILED CIRCUIT DESCRIPTION.

4-13. **A11 Power Supply Circuits.** The power supply provides the main power for the logic and analog circuits. Refer to Figure 4-2.

4-14. Line power is connected to transformer T1 via line filter FL1, fuse F1, and line voltage selector switch S2. Line filter FL1 keeps internally generated RF signals from appearing on the power connecting cable thus preventing unwanted electromagnetic radiation. Line switch S2 alters the connections to the primary of T1 which allows the Model 1130 to be operated from line voltages from 100 to 240 volts.

4-15. One of the two secondary windings on T1 is connected through full-wave bridge CR1 to regulator U4. This regulator generates a +5 volt regulated voltage for the instrument logic and display circuits. Capacitor C18 provides the essential energy storage which reduces the ripple voltage at the input of U4. C15 provides local bypassing of the regulator circuits and diodes CR5 and CR10 protect the integrated regulator from reverse power.

4-16. The other secondary winding of T1 is connected through full-wave bridge CR2 to regulators U5 and U6. These regulators are enclosed in feedback loops to improve regulation and increase the operating voltages from 5 to 15 volts. Capacitors C16 and C17 reduce input ripple voltage and CR6, CR11, CR8, and CR9 provide reverse voltage protection. Reference U3 is the primary voltage reference for the power supply. Precision resistors R10a, b, and e configure U2a for a gain of +1.5. This converts the +10.00 volt output of U5 to +15.00 volts. R10f and d configure U2b for a gain of -1 which inverts the +15.00 volt supply to -15.00 volts. Zener diodes CR3 and CR4 are required to insure proper startup of the supply, and are normally reverse biased when the supplies are operating properly. C13 and C14 provide local bypassing to maintain loop stability as the supply loading changes.

4-17. An additional 5 volt regulator, U4, supplies power to the power-fail circuits. The operating voltage for U4 is the

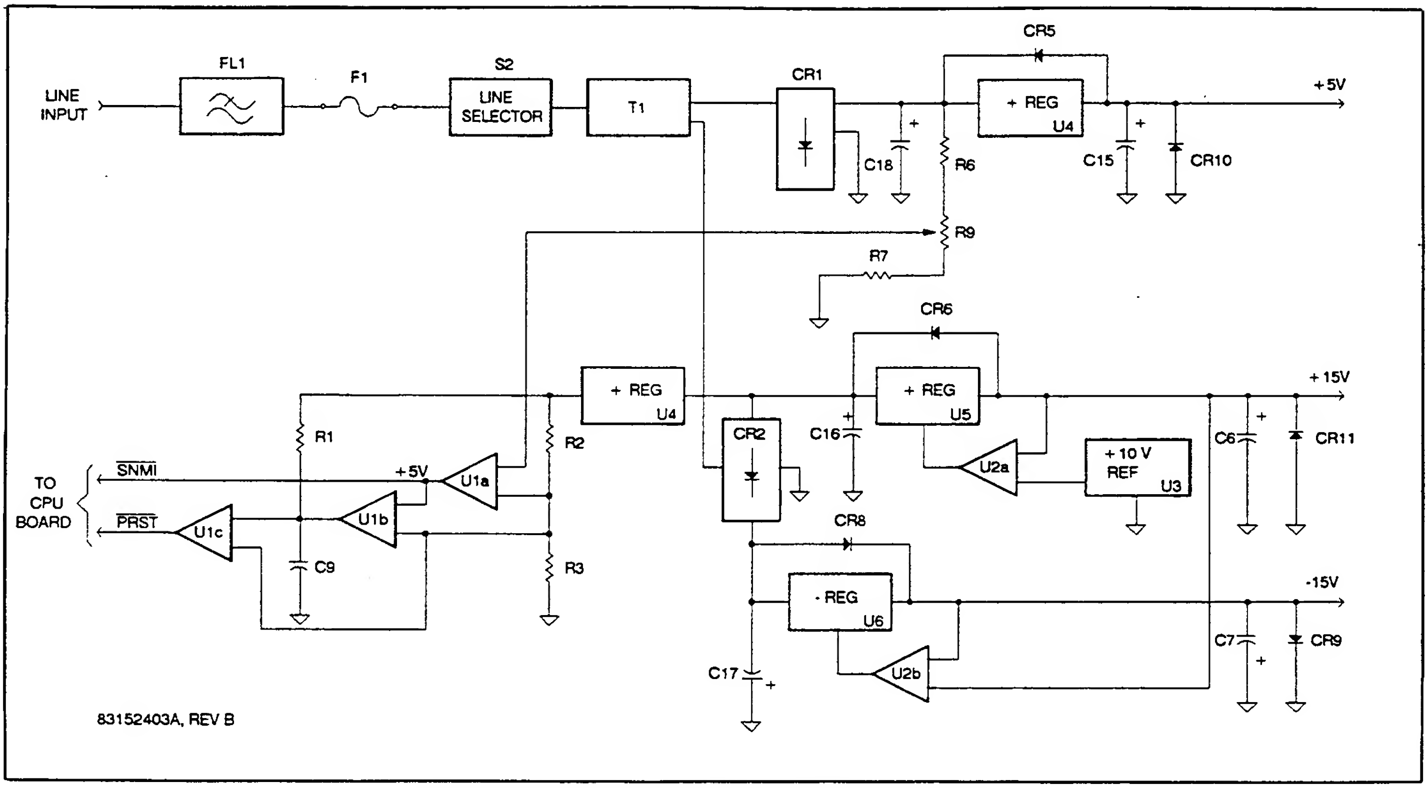

Figure 4-2. Power Supply Circuits Block Diagram.

+15 volt supply input voltage which is about 20 volts at nominal line. This insures that the output of U4 will be maintained as long as possible when line voltage is removed.

4-18. The power-fail circuit operates to properly isolate the random access memory from logic circuitry when the line voltage drops or the instrument is switched off. Comparator U1a monitors the unregulated voltage which supplies the 5 volt logic supplies. Resistors R2 and R3 divide the power-fail circuit supply by two as a reference for U1a. If the power line voltage drops to about -11 % of nominal, U1a switches, pulling line SNMI low. This activates the power-fail sequence which interrupts the microprocessor and isolates the random access memory. U1b buffers the SNMI signal and drives a delay network, R1 and C9. When the open-collector output of U1b goes low, C9 is discharged quickly. This output is buffered by U1c to drive the PRST line which resets the CPU circuitry. When the output of U1b switches off, the PRST signal is delayed by the time required to charge C9 to one half of the power-fail supply voltage. This prevents multiple CPU resets as the supply voltage decays toward zero.

4-19. A10 Motherboard Circuits. The motherboard circuitry provides the main interconnect for the operating circuits of the Model 1130. The motherboard circuits include the connectors for the plug-in boards, the power supply connectors and instrument data and address buffers for the analyzer analog sections.

4-20. Address decoding on the counter plug-in board generates the Master Analyzer Enable (MAE) signal which enables address decoder U1 and tri-state buffer U2. MAE is only active during instrument data write cycles to the analyzer circuits and inhibits RF generated noise caused by the many data transfers between the CPU and counter plug-in boards. Voltage regulator U3 supplies +5 volts for U1 and U2. The regulator input is supplied from the +15 volt regulated supply which is free from CPU related noise.

4-21. A5 CPU Circuits. The CPU circuits are the central control circuits of the instrument. They receive input commands and data from the front panel keyboard or an IEEE-488 interface and configure the internal circuits of the instrument in accordance with the input commands and data. Storage facilities for up to 99 complete front panel setups are also provided. Refer to figure 4-3.

4-22. The Z-80 CPU, U7, executes a control program resident in read-only memory, (ROM) U14. Program variables and front panel setups are stored in random-access memory, (RAM) U11. Local communications on the CPU board are via the high-speed data bus D0 through D7 and address bus A0 through A15. Memory address space partitioning is divided equally between RAM and ROM and is ac-

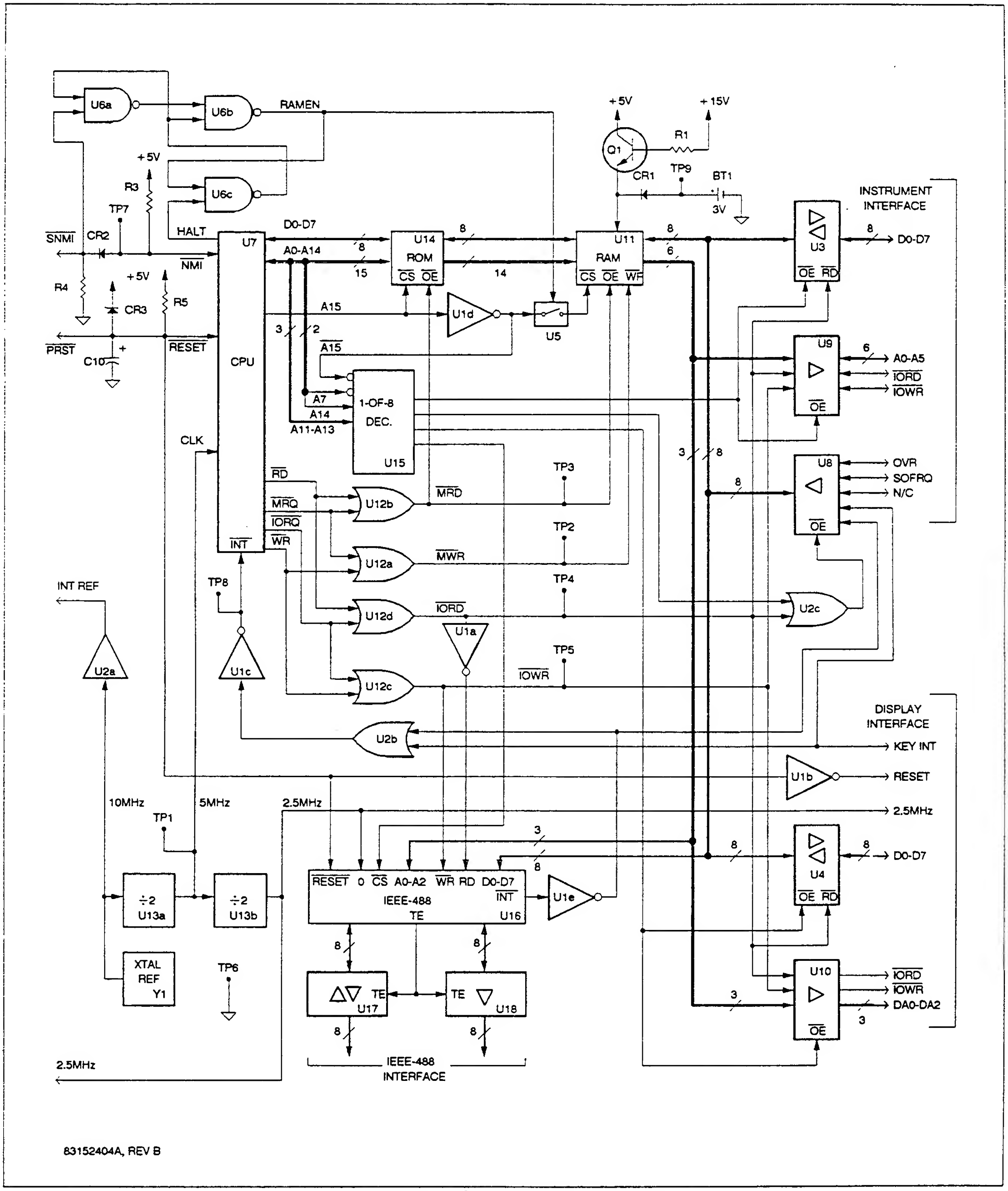

Figure 4-3. CPU Circuits Block Diagram.

complished through inverter U1d. All other instrument peripherals are partitioned in the I/O address space which is accomplished with decoder U15. U12a, b, c, and d generate memory read and write signals and I/O read and write signals for qualifying data transfers between memory or I/O peripherals and the CPU.

4-23. The RAM is powered from a non-volatile power supply consisting of Q1, CR1 and BT1. If a power fault occurs, circuits in the power supply activate the SNMI line which in turn activates the NMI processor interrupt line. This causes the processor to stop the control program and execute a HALT instruction which sets the HALT pin low. This inhibits further write cycles to the RAM by setting a latch formed by U6c and d which disconnects the chip select (CS) line to the RAM using analog switch U5. Signal PRST is also set low shortly after SNMI is activated, causing the CPU to be reset to the program start. When proper operating voltage is restored, the SNMI line returns high releasing NMI and restoring the RAM CS connection. During the power down interval the RAM is powered by BT1.

4-24. Microprocessor timing is controlled by a 5 MHz clock which is derived from a 10 MHz TCXO, Y1, and flip-flop divider U13a. The clock signal is further divided by U13b to 2.5 MHz which is used by the IEEE-488 microcontroller, U16, and by the display circuits. The 10 MHz TCXO output is also buffered through U2a and is used for the internal timebase reference for the frequency counter circuits.

4-25. All IEEE-488 interface operations are conducted by U16 in conjunction with the microprocessor interrupt routines. These routines move data into and out of memory buffers as required in response to bus commands. U17 and U18 are buffer circuits which connect U16 to the IEEE-488 bus via J20. These buffers meet the electrical requirements of the IEEE-488.

4-26. Interrupt oriented control enables the CPU and control program to respond quickly to peripheral activity. When bus activity occurs, U16 sets the INT line via U1e, U2b and U1c. When a display/keyboard interrupt occurs the KEY INT line sets the microprocessor interrupt line through U2b and U1c. The microprocessor determines the source of the interrupt by reading the interrupt status buffer, U8, and services the requesting peripheral device.

4-27. The instrument bus interface adapter consists of U3, U9, R8, and R9. These tri-state buffers are normally in the high-impedance mode during all memory transfers and I/O data transfers occurring between the CPU and the display/keyboard circuits or the IEEE-488 interface.

4-28. The display/keyboard bus interface adapter consists of U4 and U10. These tri-state buffers are only active during display/keyboard circuit transactions.

4-29. **A12 Display And A13 Keyboard Circuits.** The display and keyboard circuits provide the operator interface to the Model 1130 circuits. Key closures are detected and sent to the microprocessor which interprets and modifies the display LEDs appropriately.

4-30. The software configurable display/keyboard microcontroller, U4, is programmed to operate 16 display digits. All of the seven segment displays are connected to a common cathode driver bus which is generated by U4 and buffered through U1 and current limiting resistors R1a through h. The LED anodes are individually connected to a one-of-sixteen decoder consisting of U5 and U6 and buffers U2 and U3. No additional decoders are required since all segment decoding is performed by the microprocessor and control program.

4-31. All of the alphanumeric annunciators are static and latched by octal latches U8, U9 and U10. Resistors R4, R5 and R6 limit the current through the LEDs. Decoding for these latches is accomplished by U7. The key LEDs are all static and latched by octal latches U12, U14 and U16. In addition some LEDs on the keyboard are decoded further by one-of-eight decoders U18 and U19. Resistors R7 through R10 limit the current through the keyboard LEDs.

4-32. Keyswitch decoding is accomplished by scanning the keyboard and detecting key closures. Microcontroller U4 controls the scanning of the keyboard through decoder U17 which generates the column strobes C0 through C7. Any key closure will convey the column strobe to one of eight row lines, R0 through R7, which are monitored by U4. Multiple key closures and key debouncing are handled by U4. When a keyswitch closure occurs a microprocessor interrupt is generated and processed as described in the CPU board section.

4-33. **A4 Frequency Counter Circuits.** The counter circuits provide the frequency measurement functions of the Model 1130. Additionally, the analog-to-digital converter (A/D), and the option switch are located on the counter plug-in board. Refer to Figure 4-4.

4-34. The 10 MHz internal frequency reference from Y1 on the CPU board is connected to gate U3d. The other input of U3d is a signal derived from the external reference input. If an external reference signal is present, pin 6 of U2a will be a TTL compatible signal at the external reference frequency rate. The signal is inverted by U2b and detected by CR3, C25 and R4. When a signal is present the input of inverter U2c will be a TTL low level which is the control to automatically switch to the external reference using U2d, U3a, U3b, and U3d. The output of U3b is the reference frequency for the counter circuits derived from either the internal or external source. DS2 will be illuminated when the external reference is active.

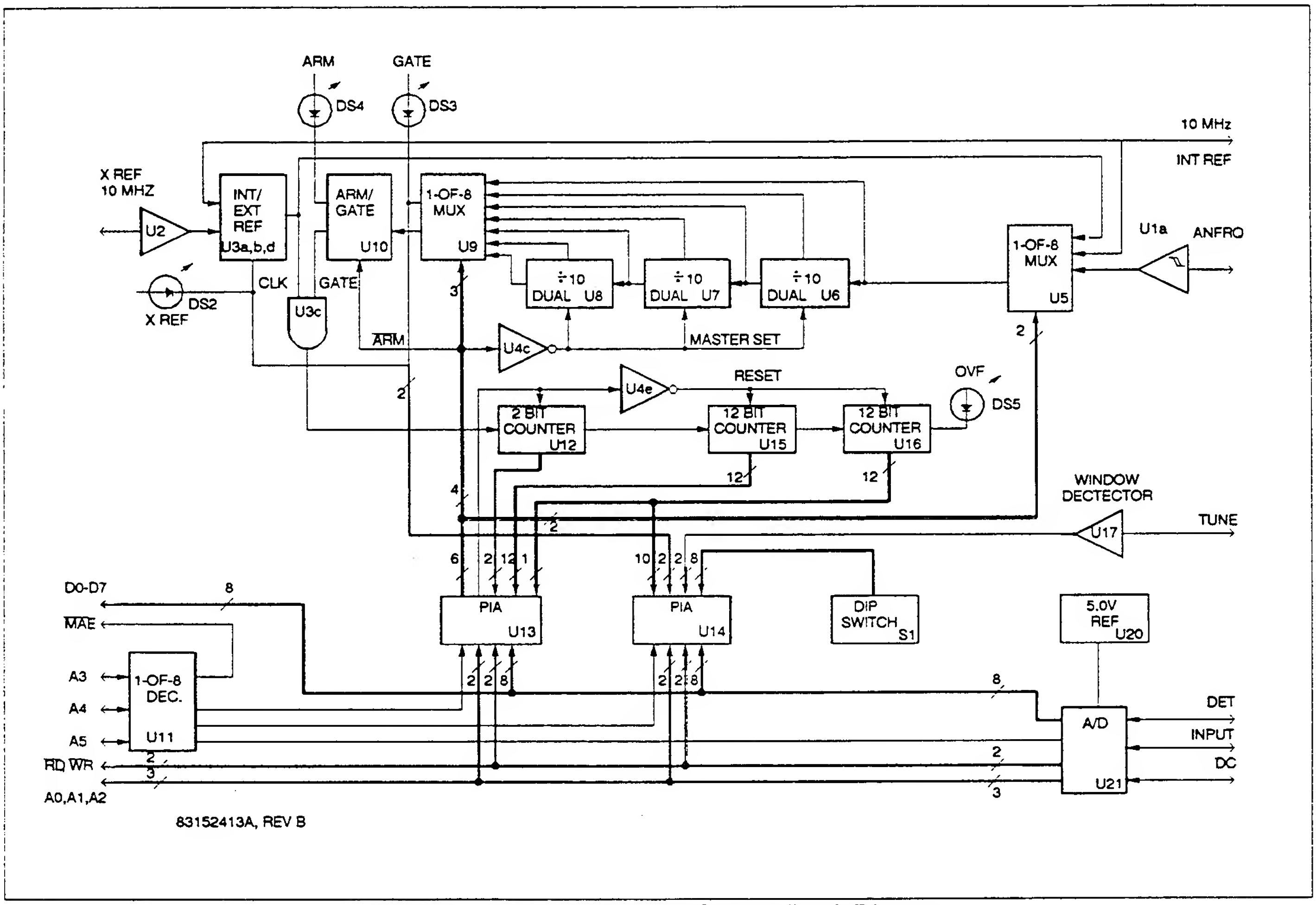

Figure 4-4. Frequency Counter Circuits Block Diagram.

4-35. The analyzer frequency line ANFRQ is generated on the filter plug-in board and is applied to hysteresis amplifier U1a and associated components. U1a acts as a buffer between the analog and digital sections of the instrument and is insensitive to the noise which is present between the analog and digital grounds. The output of U1a is applied to the input multiplexer, U5, of the counter. U5 selects one of three inputs; analyzer frequency, external reference, and internal reference, based on the state of control lines S0 and S1. The output of U5 is applied to a chain of dual decade dividers, U6, U7 and U8. These dividers are used for period selections and divide the selected input by factors of 1 to 1000000 in decade increments. All the divider output are presented to a second multiplexer, U9, which selects one of the six period divisions based on control lines T0, T1 and T2.

4-36. Dual flip-flop, U10, controls the arm and gate intervals. The output of U9 is inverted by U4b and applied to the clock input of U10a. The arm interval synchronizes the counter circuits to begin the gate interval on the next rising edge of the measurement signal. The ARM line is set low to clear flip-flop U10a. and, after being inverted by U4c, is applied to the master set (MS) lines of U6, U7 and U8. The MS sets all the divider output high which prepares the dividers to all start at count 0 with the next falling edge of the measurement signal. The rising edge of the ARM line clocks U10b, sets the U10b pin 9 high and illuminates DS4. When the falling edge of the measurement signal occurs, U10a is clocked and the gate interval begins when U10a pin 5 goes high. Simultaneously U10a pin 6 goes low which illuminates DS3 and clears the arm latch U10b. When U10b is cleared, DS4 is extinguished and U10b pin 9 is set low. The gate interval continues until U10a pin 5 is clocked low by the next rising edge at U10a pin 3. Gate U4a detects the end of the arm and gate intervals and indicates to the CPU that the count is complete. The counter will hold the count until the next arm interval is initiated. The output of U10a pin 5 goes to gate U3c which allows the reference to pass to the counter accumulator during the gate interval.

4-37. The gated reference is applied to a 26 bit accumulator consisting of U12, U15 and U16. The accumulator is cleared by a TTL low level from U13 pin 11. U4d detects the most

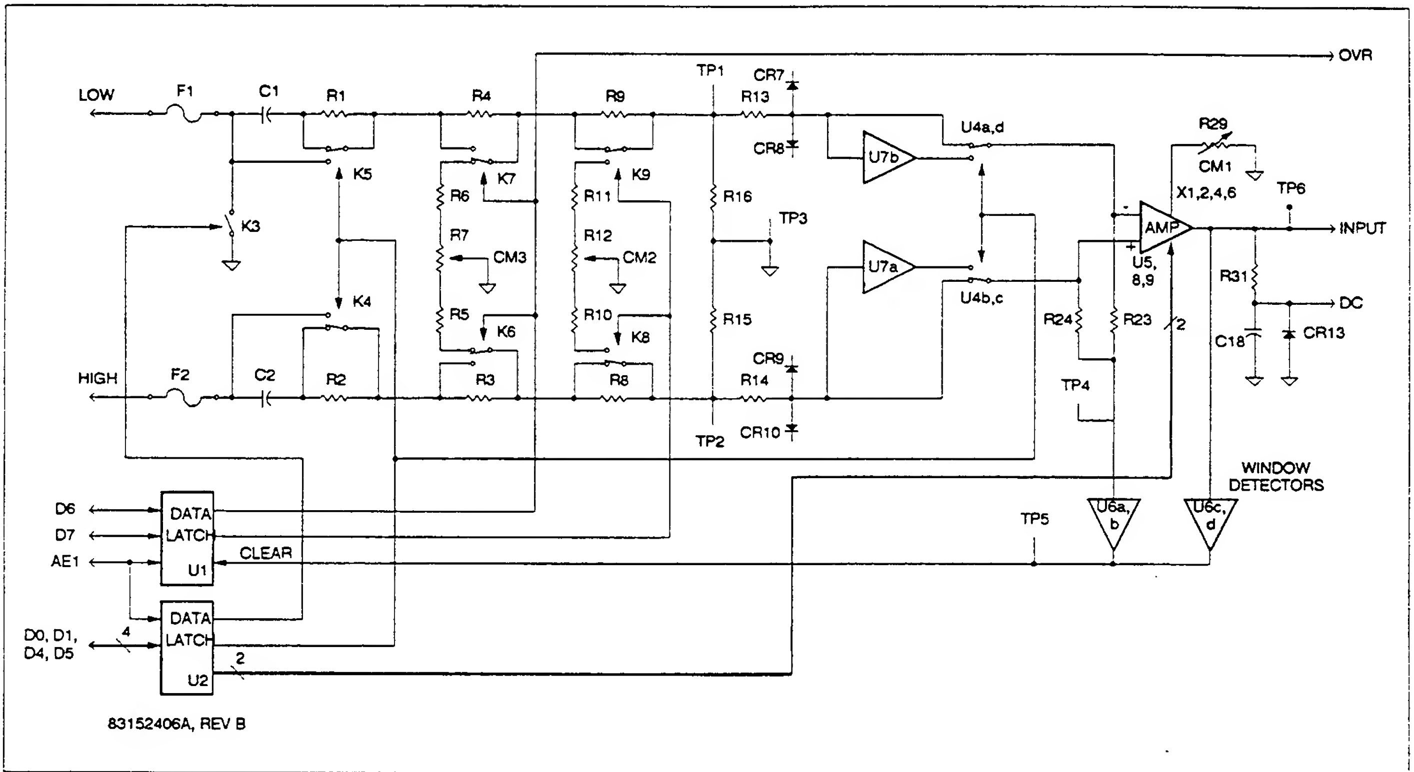

Figure 4-5. Input Circuits Block Diagram.

significant bit of the accumulator and prevents the accumulator from overflowing. The accumulator is read by the CPU through I/O devices U13 and U14.

4-38. The option dip switch is connected to one port of I/O device U14 along with lines indicating notch filter tuning status, external reference control and gate status. The TUNE line generated on the notch plug-in board is applied to a +- 10 volt window detector consisting of U17 and associated components. If the TUNE line exceeds +10 volts, U17a pin 1 will be pulled up to +5 volts by R21 and R22. If the TUNE line exceeds -10 volts, U17b pin 7 will be pulled up to +5 volts by R20 and R23.

4-39. Analog-to-digital converter (A/D), U21, converts one of four DC levels to a 12 bit binary representation where full scale is an input level of +5 volts. Reference U20 provides the 5 volt reference for the A/D converter. Auto zero capacitor C14 charges to the offset level before each A/D conversion. R28 provides a +2.5 volt offset to channel 3 of the A/D converter to allow for the bipolar input range of the DC measurement mode. A clock generating circuit consisting of R27, C15, CR10, CR11, and C16 sequences the auto-zero and conversion cycles of the A/D converter.

4-40. Address decoder U11 decodes the chip select lines for I/O devices U13 and U14, and A/D converter U21. The master analyzer enable command used on the mother board, MAE, is also generated by U11.

4-41. **A0 Input Circuits.** The input circuits provide the attenuation and initial gain along with over voltage protection and AC/DC mode switching for the Model 1130. Refer to Figure 4-5.

4-42. The audio input signal is applied to the input plug-in board through low-pass filters L3, L4, C23, and C24 to reduce RF interference. Fuses, F1 and F2, prevent damage due to excessive input level. Float mode relay, K3, connects the LOW terminal to chassis ground in the non-floating mode. K3 is energized through transistor Q3 by data latched in U2 from the CPU circuits. AC coupling capacitors C1 and C2 are bypassed in the DC level mode by relays K4 and K5. Resistors R1 and R2 discharge C1 and C2 in the AC mode. Relays K4 and K5 are energized through transistor Q4 by data latched in U2 from the CPU circuits.

4-43. A 40 dB attenuator is formed by resistors R3 through R7, R15, and R16. This attenuator is engaged by relays K6 and K7 for level ranges above 30 volts. High frequency compensation is provided by C6 through C9 and C30 through C33. Common mode adjustment R7 adjusts the attenuation balance between the high and low inputs when the attenuator is engaged. Relays K6 and K7 are energized through transistor Q5 by data latched in U1 from the CPU circuits.

4-44. A 20 dB attenuator is formed by resistors R8 through R11, R15, and R16. This attenuator is engaged by relays K8 and K9 for level ranges between 3 and 30 volts. High frequency compensation is provided by C5, C10, C13, C14, C21, and C22. Common mode adjustment R12 adjusts the attenuation balance between the high and low inputs when the attenuator is engaged. Relays K8 and K9 are energized through transistor Q6 by data latched in U1 from the CPU circuits. Over voltage protection is provided by clamping diodes CR7 through CR10 and R13 and R14.

4-45. In the DC level mode, buffers U7a and U7b are switched in the signal path by analog switch U4. U7a and b are low DC offset devices which are necessary for DC level measurement accuracy. Analog switch U4 is wired in a DPDT form and is controlled by data latch, U2, which also energizes K4 and K5. Instrumentation amplifier consisting of U5, U8, U9, and associated components provides programmable gains of X1, X2, X4, and X6. Gain setting resistors R17 through R22 are configured by K1 and K2 for gain selections. Relays K1 and K2 are energized through Q1 and Q2 and resistors R43 and R44 by data latched in U2. High frequency compensation is provided by C3, C4, C25, C28 and C29. Amplifier U9 and resistors R25 through R29 form the differential to single-ended converter stage of the instrumentation amplifier. R29 enables the adjustment of the common mode rejection of the stage.

4-46. The common mode and differential signals are separately monitored by window detectors U6a through d for peak voltages exceeding +-10 volts. The common mode signal is formed by summing the outputs of U5 and U8 with resistors R23 and R24. The +-10 volt window is formed by CR11, CR12, and R26. Any common mode or differential peak amplitude exceeding +-10 volts will cause the open-collector output of the detecting device to sink to -15 volts. This signal is applied through R30 and R34 to the latch clear inputs of U1. Clearing latch U1 will engage the 40 dB attenuator and remove the overrange condition. The state of the 40 dB attenuator is monitored by the CPU circuits through the overrange status line, OVR, connected to U1 pin 9.

4-47. In the DC level measurement mode the DC level at the output of the instrumentation amplifier U5, 8 and 9 is filtered by R31, C18 to reduce AC ripple and clamped positive by CR13. The DC signal is then measured by one channel of the A/D converter on the counter plug-in board and used for the DC level display.

4-48. **A1 Filter Circuits.** The output of the Input circuits is further amplified by the filter plug-in board and the rms value of the AC signal is detected. The audio signal is also passed through a schmitt trigger circuit providing a TTL compatible square wave for the counter circuits. Up to two optional filter modules can be installed on the filter board and inserted into the signal path. Refer to Figure 4-6.

4-49. The signal from the input plug-in board is AC coupled to programmable gain amplifier U1 through C1, C2, and R1. Gain selections of X1, X2.5, and X5 are determined by R2, R3 and R4 and are selected by analog switch U2a, b and c. Gain selection data from the CPU board is latched in U3. Dual one-of-four decoder U4 decodes the data and enables one of the three gain selections.

4-50. The output of the amplifier U1 is applied to a schmitt trigger circuit consisting of U5, R5, R6, R7 and CR1 through CR4. The output of U5 is a TTL compatible square wave which is measured by the counter circuits in the frequency measurement mode. A monolithic rms-to-DC converter, U6, converts the AC signal to a DC level representing the rms value of the waveform. Capacitor C7 is required by U6 for filter averaging. The output of U6 is measured by one channel of the A/D converter on the counter plug-in board. The signal level is measured at this stage in the analyzer circuits for distortion and SINAD measurement calculation and for autoranging the input attenuators and amplifiers.

4-51. Analog switches U7a, b, and d and buffer U8 are used to bypass or select one of two optional filter modules when installed. Filter selection data from the CPU circuits is latched in U3 and decoded by U4.

4-52. **A2 Notch Filter Circuits.** The notch filter is an automatically tuned and balanced state-variable notch filter. The filter is inserted into the signal path to remove the fundamental frequency component and pass harmonics and noise for the distortion and SINAD measurement modes. Refer to Figure 4-7.

4-53. The notch filter consists of a state-variable band-pass filter and a balance amplifier, U3a. In operation the band-pass filter is tuned to the fundamental frequency measured by the counter circuits. The output of the band-pass filter is then subtracted from the input signal, leaving only the harmonic and noise components of the input signal. Fine adjustment of the notch center frequency and the amplitude of the band-pass output is accomplished by two control loops which operate to reduce the in-phase and quadrature components of the fundamental signal at the output of the balance amplifier.

4-54. The individual integrators in the filter are identical, so only one will be described in detail. The output from summing amplifier U1a is applied to a series of eight resistors. The values of these resistors, R6 through R13, are chosen in a binary series to operate as a discrete 8 bit D/A converter. These resistors are selected for frequency tuning within a selected frequency band by FET switches Q1 through Q8. Capacitors C3 through C7 are selected by FET switches Q9 through Q12 for integrator tuning over five frequency bands. Integrating amplifier U3b completes the integrator (TP2). Coarse tuning of the filter is provided by the selection of resis-

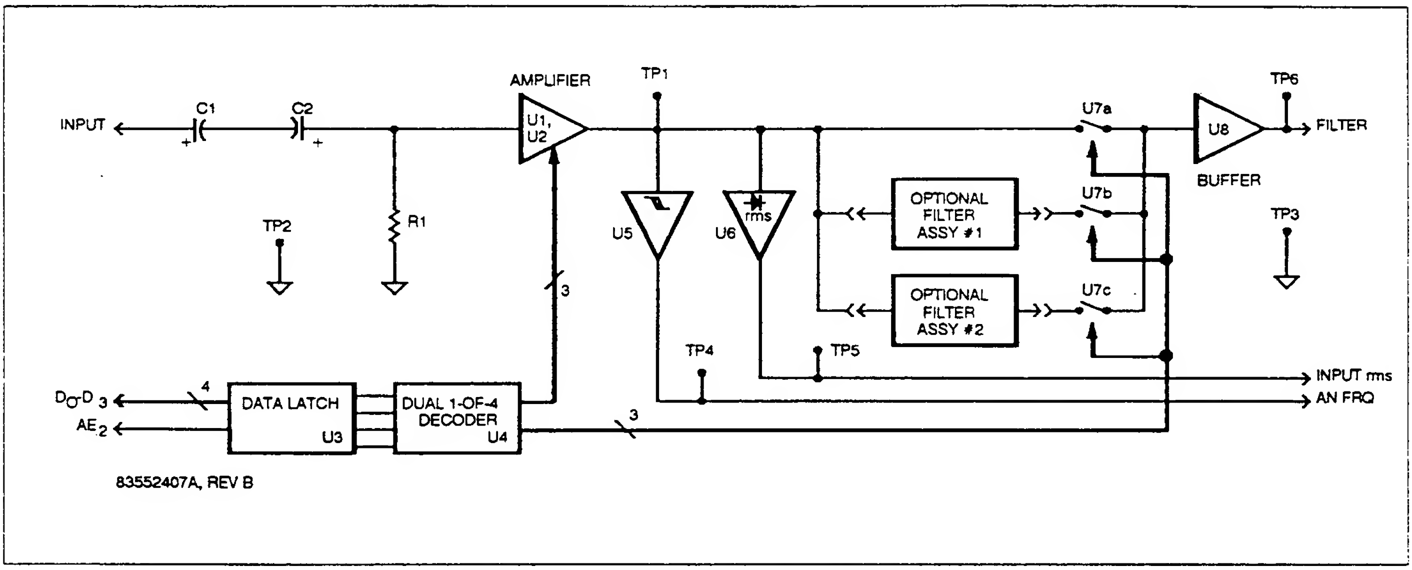

Figure 4-6. Filter Circuits Block Diagram.

tor and capacitor combinations by the control program. Data from the control program is latched in data latches U4 and U5. The 12 comparators contained in U6, U7, and U8 and associated pull-up resistors R29, and R30 act as level translators to convey the latched TTL data to gate drive levels necessary to operate the FET switches.

4-55. The band-pass filter output is generated at the output of inverting amplifier U2a (TP3). Balance amplifier U3a subtracts the band-pass output from the filter input signal forming a notch filter response. The output of the balance amplifier is further amplified with a gain of 10 by U10 and associated circuits. Analog switch U11a and b in conjunction with buffer U12a select the gain depending on range information from the control program. The output of U12a (TP10) is further processed by the detector circuits and used in the distortion and SINAD measurement modes.

4-56. The balance and tuning of the filter is controlled by synchronously detecting and reducing the in-phase and quadrature components of the fundamental at the output of U12a. Comparators U13a and b detect the in-phase (TP2) and quadrature (TP5) signals in the band-pass filter and generate gate switching levels for chopper FETs Q25 and Q26. Amplifier U12b inverts the output of U12a and provides an out-of-phase signal to be used in generating full-wave rectified signals for the tune and balance integrators. The rectifier operates as follows: During the time that switches Q25 and Q26 are shorted to ground a current flows in resistors R48 and R49 to the integrators. When Q25 and Q26 are open, twice as much current of the opposite phase flows through resistors R42, R47 (TP6), R43, and R50 (TP8). Since the currents are out of phase, the net current flow is the same and in the same direction providing a full-wave rectified current to the integrators. Integrating amplifiers U14 and U16 generate error voltages in proportion to any in-phase or quadrature error currents. The integrator time constants are selected by analog switch U15 and capacitors C27 through C30 to allow optimum tracking dynamics across the tuning range of the filter. The tune and balance error voltages are applied to four-quadrant multipliers U17 and U18. The current outputs through pin 4 of each multiplier is summed together and amplified by U1b. The output of U1b is the product of the tune and balance error voltages and the in-phase and quadrature signals which are summed back into the filter through U1a to cancel tuning and balance errors. The control loops can be disabled to aid in troubleshooting the notch filter circuits by removing jumper J1.

4-57. A tune status output signal is generated by tune integrator U14 (TP11). A window detector on the counter plug-in board monitors the tune status to determine if the notch filter is properly tuned. Tune and balance adjustments R57 and R58 are adjusted to null out any error voltages in the control loops which would limit the effective depth of the notch filter.

4-58. A3 Detector Circuits. The detector circuits provide the post notch gain, low-pass filters and the rms and average detectors for the Model 1130. Refer to Figure 4-8.

4-59. Relay K1 is selected by the control program to insert the notch filter into the signal path in the distortion and SINAD measurement modes. In all other modes the filter is bypassed. Analog switches U3a and b with resistors R3 and R4 form a programmable attenuator with 0 dB or 20 dB of attenuation. This attenuator is followed by amplifier U4 having a gain of 20 dB determined by R5 and R6. The at-

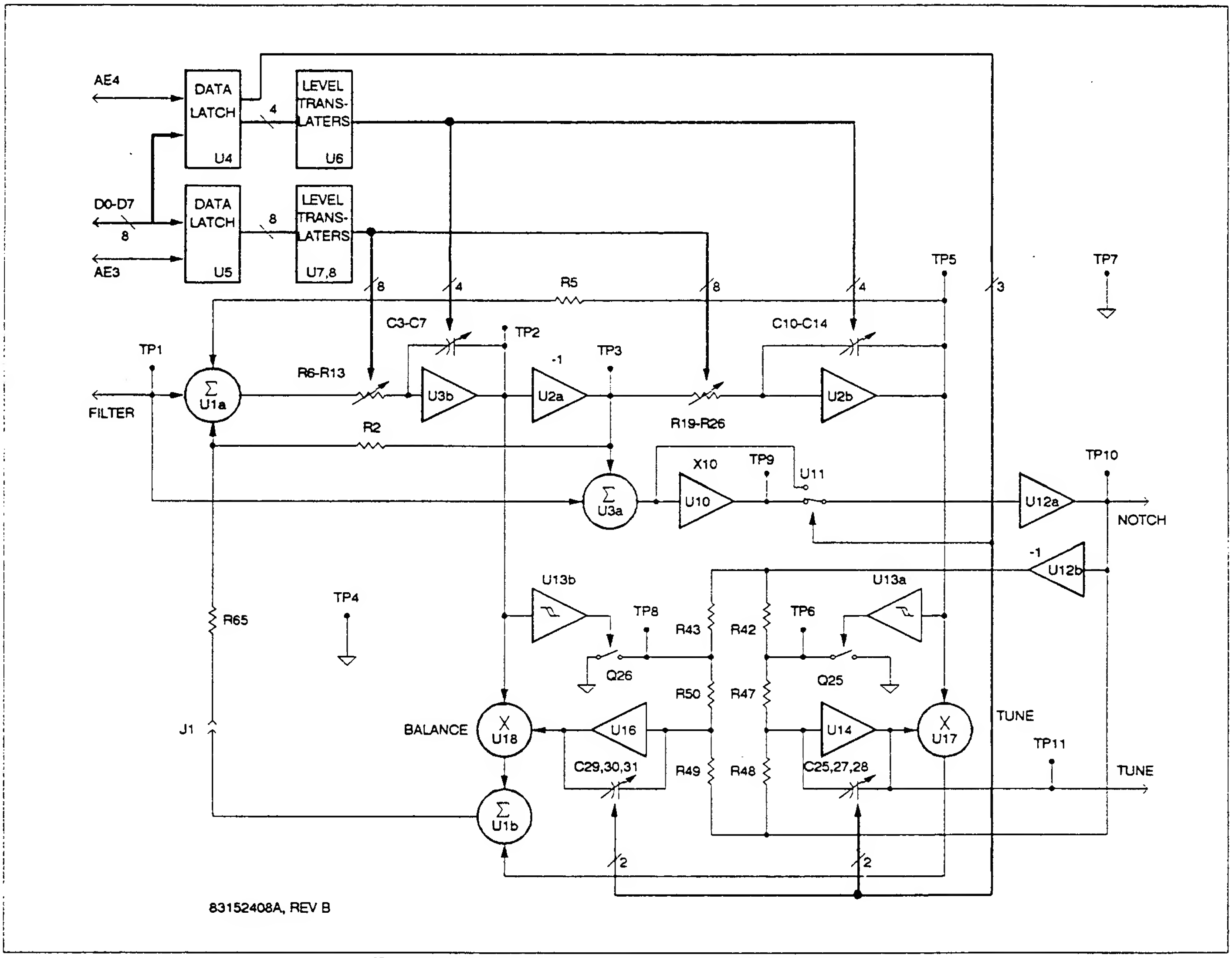

Figure 4-7. Notch Filter Circuits Block Diagram.

tenuator and amplifier combination form a programmable 0 dB or 20 dB gain stage. The amplifier is actively clamped by diodes CR2 and CR3 to the bipolar voltage reference formed by CR6, CR7, and R13. All output swings of amplifier U4 will be limited to less than +- 10 volts peak preventing the stage from saturating and enabling fast recovery after transients. The output of U4 (TP1) is AC coupled to another programmable attenuator consisting of analog switch U5a through d and R7 through R10. Amplifier U7 is an identical clamped gain stage as U4 with a gain of 20 dB. The combination of the attenuator and amplifier form a programmable gain stage with gain selections of 1X, 2X, 5X, and 10X.

4-60. Following the gain stages (TP2) is the low-pass filter selections. Analog switch U8 selects the various filter values for the 30 kHz, 80 kHz, 220 kHz or 500 kHz low-pass filters. Unity gain buffer U9b completes the selected filter (TP3).

4-61. Amplifier U9a and associated components form a 5 Hz high-pass filter which determines the low frequency bandwidth of the Model 1130. Buffer amplifier U10a and CR8, CR9 and R27 present the detector output signal to the rear panel MONITOR output connector for external analysis (TP4).

4-62. The complete detector amplifier and attenuator chain is programmable for a gain change of 0 to 40 dB in 1X, 2X, or 5X increments. In the distortion and SINAD modes the 20 dB amplifier on the notch filter plug-in board increases the chain to a total combined gain of 60 dB. The programmable gain is required to maintain a constant level of between 1.2 and 3 volts at the rms and average detectors to preserve the resolution and accuracy of the analyzer over a wide dynamic range. The rms detector consists of U11 and associated components. The output of the rms detector (TP5) is a DC level

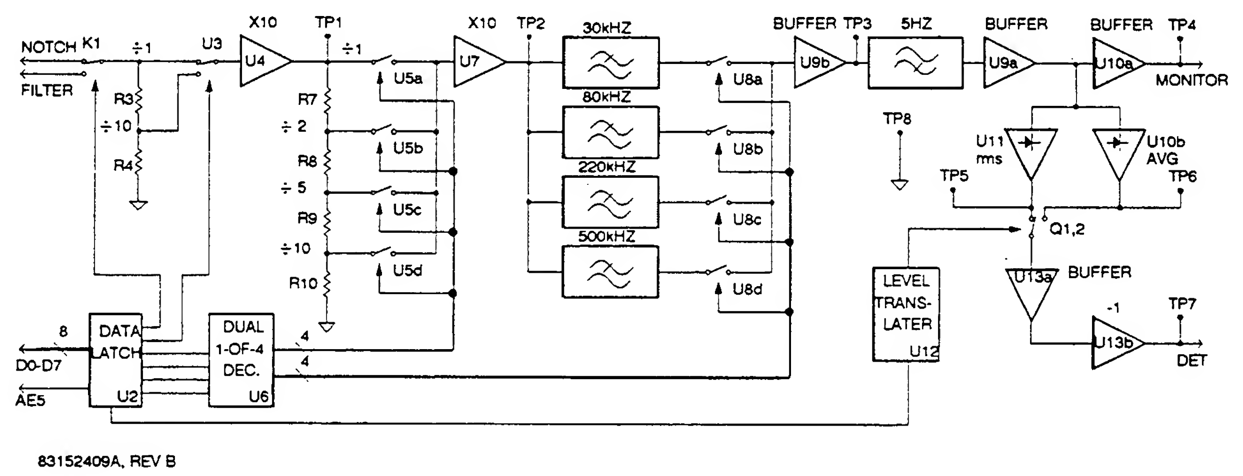

Figure 4-8. Detector Circuits Block Diagram.

equal in amplitude to the rms value of the input signal. The average detector consists of U10b and associated components. U10b forms a full wave rectifier circuit and C32 filters the output to a DC level representing the average value of the input signal (TP6). FET switches Q1 and Q2 select one of the two detectors for measurement by one channel of the A/D converter on the counter plug-in board. Resistors R36 and R37 balance the gain of the average and rms detectors to be equal for a sine-wave input waveform. Inverting amplifier U13b presents a positive 0 to 3 volt level to the A/D converter (TP7).

4-63. Detector selection is controlled by the data latched in U2 by the control program. The TTL data from the latch is converted to gate drive levels for Q1 and Q2 by U12a and b and associated components. Gain, filter and input selection data is also latched in U2. Dual one-of-four decoder U6 decodes the latched data to analog switches U5 and U8.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This sections contains the safety requirements, required test equipment, and procedures for cleaning, removal and replacement, inspection, performance test, and adjustment for the Model 1130 Distortion Analyzer.

5-3. SAFETY REQUIREMENTS.

5-4. Although this instrument has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation, service and repair of the instrument. Failure to comply with the precautions listed in the Safety Summary at the front of this manual or with specific warnings given throughout this manual could result in serious injury or death. Service and adjustments should be performed only by qualified service personnel.

5-5. REQUIRED TEST EQUIPMENT.

5-6. Test equipment required for the performance tests, adjustments and troubleshooting is listed in Table 5-1. Any equipment that satisfies the critical specifications in the table may be substituted for the recommended models. However, the performance tests are based on the assumption that the recommended test equipment is used.

5-7. CLEANING PROCEDURE.

5-8. Painted surfaces can be cleaned with a commercial, spray-type window cleaner or with a mild soap and water solution.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in the instrument. Recommended cleaning agents are isopropyl alcohol, a solution of 1 part kelite and 20 parts water, or a solution of 1 % mild detergent and 99 % water.

5-9. REMOVAL AND REPLACEMENT.

5-10. **Instrument covers.** Remove the instrument covers as follows:

a. Disconnect the power cord and all signal cables from the instrument.

b. Remove the three screws located at the rear of the cover and slowly lift the cover up and to the rear.

c. Turn the unit over and remove the bottom cover in the same manner as the top cover was removed.

d. To replace the covers reverse the removal procedure.

5-11. **Display/Keyboard Access.** To gain access to the display and keyboard proceed as follows:

a. Remove the instrument covers as described in paragraph 5-10.

b. Remove the three screws that hold the top trim extrusion and remove the trim strip.

CAUTION

When removing the display window be careful not to scratch the inner surface of the window.

c. Remove the plastic display window.

d. Turn the instrument over and remove the three screws that hold the bottom trim extrusion and remove the trim strip.

e. Tilt the bottom of the front panel away from the instrument until all switches are clear. Pull the front panel up to clear the center trim extrusion for access.

f. To replace the display/keyboard reverse the removal procedure.

5-12. **Plug-in Circuit Boards.** Remove the plug-in circuit boards as follows:

a. Remove the instrument covers as described in paragraph 5-10.

b. Grasp the circuit board extractors, pull up, and slide the circuit board up and out of the instrument.

TABLE 5-1. RECOMMENDED TEST EQUIPMENT.

INSTRUMENT	CRITICAL SPECIFICATIONS	USAGE			MODEL
		PERFORMANCE EVALUUATION	ADJUSTMENT	TROUBLE-SHOOTING	
AC/DC Calibrator	**Frequency Range:** 10 Hz to 200 kHz **Level Range:** 1mV to 300 V **Flatness:** + - 0.3 %; 10 - 30 Hz + - 0.25 %; 30 Hz - 200 kHz **AC Accuracy:** + - 0.1 %; 50 Hz - 50 kHz **DC Accuracy:** + - 0.05 %	X		X	Fluke Model 5100B-03
Test Oscillator	**Frequency Range:** 5 Hz to 500 kHz **Level Range:** 0 to 3 V rms **Flatness:** + - 0.3 dB	X			Tektronix Model SG502
Frequency Counter	**Frequency Range:** 10 Hz to 200 kHz **Accuracy:** 0.1 ppm	X			HP Model 5345A
Low Distortion Audio Oscillator	**Frequency Range:** 10 Hz to 140 kHz **Level Range:** 3 mV to 3 V **Residual Distortion:** .01 %; 10 Hz to 20 kHz .02 %; 20 KHz to 50 kHz .056 %; 50 kHz to 100 kHz .1 %; 100 kHz to 140 kHz	X	X	X	BEC Model 1110 or 1120
Wave Analyzer	**Frequency Range:** 20 Hz to 50 kHz **Bandwidth:** 10 Hz **Display Range:** 70 dB		X		HP Model 3581A
Frequency Standard	**Frequency:** 10 MHz **Level:** TTL compatible **Accuracy:** 0.1 ppm		X		House Standard
Variac/Line Monitor	20 % variation about 100, 120 or 240 volts		X		Powerstat Model 3PN116B
Balanced Cable	Two conductor shielded balanced line	X	X	X	Boonton 954021
Adapters (4 req.)	Single binding post to BNC (M)	X	X	X	Boonton 954018

c. To replace the circuit board reverse the removal procedure.

5-13. Optional Filters. Install the optional filters as follows:

a. Remove the instrument top cover as described in paragraph 5-10.

b. Remove the Filter board (brown extractors). Refer to paragraph 5-12. Place the board on a flat working surface with the components up and the extractors at the top.

NOTE

There are two positions available for optional filters. These positions are located on the right and left-center part of the circuit board. The right position corresponds to optional filter No. 2 which is activated by the rightmost optional filter key on the front panel and the left-center position corresponds to optional filter No. 1 which is activated by the leftmost optional filter key. Either position will accommodate any of the available optional filters.

c. Install the optional filter in the desired position and replace the circuit board.

WARNING

There are voltages at various points in the instrument which can, if contacted, cause personal injury. Observe all safety precautions. Service and adjustments should be performed by trained service personnel only.

d. Set the option switch A4S1-7 to the open position and connect power to the instrument.

e. Set the LINE ON/OFF switch to ON and depress the LCL/INIT key.

f. After the initialization sequence is complete, depress the SPCL key and enter the special option number listed in Table 5-2 that defines the filter type and position for each filter installed .

g. Set the option switch A4S1-7 to the closed position and set the LINE ON/OFF switch to OFF.

h. Disconnect all power to the instrument and replace the instrument top cover.

5-14. Firmware Integrated Circuit. Remove the EPROM as follows:

a. Remove the instrument top cover as described in

TABLE 5-2. OPTIONAL FILTERS.

FILTER TYPE	SPECIAL OPTION CODE		CALIBRATION SETTINGS	
	LEFT POSITION	RIGHT POSITION	FREQUENCY	LEVEL
NO FILTER	10	20	N/A	N/A
400 Hz	11	21	1000 Hz	3.000 V
CCITT	12	22	800 Hz	3.000 V
CCIR	13	23	6300 Hz	3.000 V
CCIR/ARM	14	24	6300 Hz	3.000 V
A WTNG	15	25	1000 Hz	3.000 V
B WTNG	16	26	1000 Hz	3.000 V
C WTNG	17	27	1000 Hz	3.000 V
AUDIO	18	28	1000 Hz	3.000 V
C-MESSAGE	19	29	1000 Hz	3.000 V

paragraph 5-10.

b. Remove the CPU board (green extractors). Refer to paragraph 5-12. Place the board on a flat, non-conductive working surface with the components up.

CAUTION

When removing and replacing an integrated circuit (IC) note the mark or notch used for pin number identification.

c. Locate EPROM A6U14. Remove the IC with a straight pull away from the board.

d. Install the replacement IC and replace the circuit board.

WARNING

There are voltages at various points in the instrument which can, if contacted, cause personal injury. Observe all safety precautions. Service and adjustments should be performed by trained service personnel only.

e. Connect power to the instrument and set the LINE ON/OFF switch to ON.

f. Depress the LCL/INIT key to initialize the instrument. The new firmware number will appear in the FREQUENCY display for a few seconds before the instrument resumes normal operation.

g. Set the LINE ON/OFF switch to OFF, disconnect all power to the instrument and replace the instrument top cover.

5-15. **Component Removal.** Most components are readily accessible for inspection and replacement when the instrument covers are removed. Solid-state circuit components, mounted on plug-in circuit boards, are used throughout the instrument. Standard printed circuit board maintenance techniques are required for removal and replacement of parts. Excessive heat must be avoided; a low wattage soldering iron and suitable heat sinks should be used for all soldering and unsoldering operations.

5-16. INSPECTION.

5-17. If an equipment malfunction occurs, perform a visual inspection of the instrument. Inspect for signs of damage caused by excessive shock, vibration, or overheating, such as broken wires, loose hardware and parts, loose electrical connections, or accumulations of dirt and other foreign matter. Correct any problems discovered, then perform the performance tests to verify that the instrument is operational. If a malfunction persists or the instrument fails any of the performance tests, refer to the adjustment procedure. After the instrument has been adjusted, perform the performance tests again to verify instrument operation.

5-18. PERFORMANCE TESTS.

5-19. The performance tests should be performed about every 12 months or after the instrument has been repaired. The performance tests may also be performed when the instrument is first received to verify instrument performance.

5-20. **Initial Calibration.** Calibrate the instrument as follows:

a. Set the LINE ON/OFF switch to ON and depress the LCL/INIT key to initialize the instrument.

b. Enable the Analyzer input float mode.

c. Connect the 50 Hz - 50 kHz Calibrator output to the Analyzer input HI and LOW using the balanced cable and adapters.

d. Set the Calibrator to a frequency of 1 kHz and a level of 3.000 volts and enable the Calibrator output.

e. After the Analyzer measurement settles, enter special function 20 to calibrate full scale AC level. The FREQUENCY display will indicate the - CAL - message momentarily and any errors will be reported. The calibration will take approximately 2 seconds after which the FREQUENCY display will indicate special function 10.

f. If any of the optional filters are installed, set the Calibrator to the reference frequency and level listed in Table 5-2 designated for the filter to be calibrated and enable the Calibrator output.

g. Enter the special function that corresponds to the filter position to be calibrated. Special function 21 will calibrate the optional filter No. 1 installed in the leftmost position while special function 22 calibrates optional filter No. 2 installed in the rightmost position. The FREQUENCY display will indicate the - CAL - message momentarily and any errors will be reported. The calibration will take approximately 1 second after which the FREQUENCY display will indicate special function 10.

h. Set the Calibrator to a level of 0.000 volts DC and depress the Analyzer DC key to enable the DC level measure-

ment mode.

i. After the Analyzer measurement settles, enter special function 23 to calibrate DC level offset. The FREQUENCY display will indicate the - CAL - message momentarily and any errors will be reported. The calibration will take approximately 2 seconds after which the FREQUENCY display will indicate special function 10.

j. Set the Calibrator to a level of 3.000 volts DC.

k. After the Analyzer measurement settles, enter special function 24 to calibrate full scale DC level. The FREQUENCY display will indicate the - CAL - message momentarily and any errors will be reported. The calibration will take approximately 1 second after which the FREQUENCY display will indicate special function 10.

5-21. **DC Level Accuracy.** On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument. After the initialization sequence is complete, enable the Analyzer floating mode, enable the DC low-pass filter and enter special function 17 to enable the slow detector mode. Connect the DC Calibrator output using the balanced cable and adapters to the Analyzer input HI and LOW terminals. Enter the Calibrator settings listed in Table 5-3 and record the Analyzer DC level readings.

5-22. **AC Level Accuracy.** On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument, enable the Analyzer floating mode and enter special function 17 to enable the slow detector mode. Connect the 50 Hz - 50 kHz Calibrator output using the balanced cable and adapters to the Analyzer input HI and LOW terminals. Enter the Calibrator settings listed in Table 5-4 and record the Analyzer AC level readings.

5-23. **AC Level Flatness.** The level flatness test is made in the level ratio mode where the ratio reference is set at a frequency of 1 kHz and at a specific test level. The frequency is then varied and the resultant relative amplitude measurements are recorded.

5-24. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument and enter special function 17 to enable the slow detector mode. Connect the Wideband Calibrator output using the balanced cable and adapters to the Analyzer HI and LOW inputs and connect the 50 ohm load accross the binding post adapters. Perform the following procedure for each test level listed in Table 5-5.

a. Enter the Calibrator level at a frequency of 1 kHz.

b. On the Distortion Analyzer enable the level ratio mode to set the flatness reference.

c. Enter the Calibrator test frequencies and Analyzer special functions indicated in Table 5-5 and record the Analyzer ratio measurements.

5-25. **Frequency Accuracy.** On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument. Connect the Low Distortion Audio Oscillator output HI and LOW using the balanced cable and adapters to the Analyzer input HI and LOW and enter an oscillator level of 3 volts.. Connect the SYNC output on the rear panel of the Oscillator to the Frequency Counter CHANNEL A input and set the Frequency Counter controls as follows:

FUNCTION	FREQ A
GATE TIME	100mS
DISPLAY POSITION	AUTO
LEVEL	PRESET
SLOPE	+
ATTEN	1 MEG, X1
AC/DC	AC
CHECK/COM/SEP	SEP

5-26. For each test frequency listed in table 5-6 set the Audio Oscillator to the test frequency, verify the Analyzer frequency measurement accuracy by comparing the external counter and Analyzer frequency measurement and record the result, pass or fail, in Table 5-6.

5-27. **Low-Pass Filter Accuracy.** The filter accuracy test is made by setting an amplitude ratio reference at a frequency of 1 kHz and adjusting the frequency at the same reference level for a display of -3.01 dB or 70.7 %. The frequency is then measured and checked against the specified limits.

5-28. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument. Connect the output of the Test Oscillator to the input of the Distortion Analyzer and terminate the Analyzer input with 600 ohms. Set the Test Oscillator to a frequency of 1 kHz + - 10 Hz and a level of 2 volts + - 50 mV. Enable the Analyzer level ratio mode and depress the dB key. Perform the following procedure for each low-pass filter listed in Table 5-7.

a. Enable the specified low-pass filter.

b. Adjust the Test Oscillator frequency toward the corner frequency of the selected filter for a display indication of -3.01 dB + - 0.05 dB.

c. Check the frequency against the specified limits and record the result, pass or fail, in Table 5-7.

5-29. **Residual Distortion And Noise.** In this test the Low Distortion Audio Oscillator is connected to the Analyzer and the combination of distortion and noise is

measured at various frequencies and levels. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument. Connect the Oscillator output HI and LOW using the balanced cable and adapters to the Analyzer input HI and LOW and connect the 600 ohm load across the binding post adapters at the Analyzer input. Enable the input floating mode and depress the DIST and DB keys. Set the Audio Oscillator to the levels and frequencies listed in Table 5-8, enable the low-pass filter specified in the BW column and record the distortion measurement.

5-30. Common Mode Rejection Ratio. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument. Enable the Analyzer floating mode and depress the Analyzer LEVEL key and dB key. Perform the following procedure.

a. Connect the Audio Oscillator HI output to the Analyzer HI input using the BNC cable.

b. Set the Oscillator level to 2.000 volts at a frequency of 1 kHz.

c. Enable the Analyzer ratio mode to set the common mode signal reference and enter special function 12 to hold the 3 volt input range.

d. Connect the Audio Oscillator HI output to both Analyzer HI and LOW inputs using BNC cables and a Tee adapter.

e. Set the Audio Oscillator to the test frequencies and levels listed in Table 5-9 and record the results, pass or fail.

5-31. Optional Filter Accuracy. The filter accuracy tests are made by setting an amplitude ratio reference at a reference frequency and measuring the relative amplitude at other specified test frequencies. The results are then compared to the specification limits.

5-32. Optional Filter Test Connections. Setup the test connections as follows:

a. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument and enable the Analyzer input floating mode.

b. Connect the Audio Oscillator output to the Distortion Analyzer input using the balanced cable and adapters

c. Terminate the Analyzer input with 600 ohms.

5-33. 400 Hz High-Pass Filter Accuracy. Perform the test as follows:

a. Set the Audio Oscillator to a frequency of 1 kHz and a level of 2 volts.

b. Enable the Analyzer level ratio mode and depress the dB key.

c. Enable the 400 Hz high-pass filter.

d. Adjust the Audio Oscillator frequency for an ANALYZER display indication of -3.01 dB +- 0.05 dB.

e. Check the frequency against the specified limits and record the result, pass or fail, in Table 5-7.

5-34. AUDIO Band-Pass Filter Accuracy. Perform the test as follows:

a. Set the Audio Oscillator to a frequency of 1 kHz and a level of 2 volts.

b. Enable the Analyzer level ratio mode and depress the dB key.

c. Enable the AUDIO band-pass filter.

d. Set the Audio Oscillator frequency to 22.4 Hz and fine adjust the frequency for an ANALYZER display indication of -3.01 dB +- 0.05 dB.

e. Check the frequency against the specified limits and record the result, pass or fail, in Table 5-7.

f. Set the Audio Oscillator frequency to 22.4 kHz and fine adjust the frequency for an ANALYZER display indication of -3.01 dB +- 0.05 dB.

g. Check the frequency against the specified limits and record the result, pass or fail, in Table 5-7.

5-35. CCITT Filter Accuracy. Perform the test as follows:

a. Set the Audio Oscillator to a frequency of 800 Hz and a level of 2 volts.

b. Enable the Analyzer level ratio mode and depress the dB key.

c. Enable the CCITT weighting filter.

d. Set the Audio Oscillator to the frequencies listed in Table 5-10 and record the results, pass or fail.

5-36. CCIR, CCIR/ARM Filter Accuracy. Perform the test as follows:

a. Set the Audio Oscillator to a frequency of 1000 Hz

for the CCIR filter or 2000 Hz for the CCIR/ARM filter and a level of 2 volts.

b. Enable the Analyzer level ratio mode and depress the dB key.

c. Enable the CCIR or the CCIR/ARM band-pass filter.

d. Set the Audio Oscillator to the frequencies listed in Table 5-11 for the respective CCIR or CCIR/ARM filter and record the results, pass or fail, in Table 5-11.

5-37. A, B, and C Weighting Filter Accuracy. Perform the test as follows:

a. Set the Audio Oscillator to a frequency of 1000 Hz and a level of 2 volts.

b. Enable the Analyzer level ratio mode and depress the dB key.

c. Enable the A, B, or C Weighting filter.

d. Set the Audio Oscillator to the frequencies listed in Table 5-12, 5-13 or 5-14 for the respective A, B, or C weighting filter and record the results, pass or fail.

5-38. C-MESSAGE Filter Accuracy. Perform the test as follows:

a. Set the Audio Oscillator to a frequency of 1000 Hz and a level of 2 volts.

b. Enable the Analyzer level ratio mode and depress the dB key.

c. Enable the C-MESSAGE weighting filter.

d. Set the Audio Oscillator to the frequencies listed in Table 5-15 and record the result, pass or fail.

TABLE 5-3. DC LEVEL ACCURACY TEST RECORD

DC CALIBRATOR	ANALYZER DC LEVEL MEASUREMENT		
LEVEL	MINIMUM	ACTUAL	MAXIMUM
0.500 V	0.488	________	0.512
1.000 V	0.987	________	1.013
2.000 V	1.984	________	2.016
3.000 V	2.981	________	3.019
30.00 V	29.81	________	30.19
300.0 V	298.1	________	301.9
-300.0 V	-298.1	________	-301.9
-30.00 V	-29.81	________	-30.19
-3.000 V	-2.981	________	-3.019
-2.000 V	-1.984	________	-2.016
-1.000 V	-0.987	________	-1.013
-0.500 V	-0.488	________	-0.512

TABLE 5-4. AC LEVEL ACCURACY TEST RECORD.

AC CALIBRATOR		ANALYZER AC LEVEL MEASUREMENT		
LEVEL	FREQUENCY	MINIMUM	ACTUAL	MINIMUM
1.000 mV	50 Hz	0.990	________	1.010
3.000 mV	50 Hz	2.970	________	3.030
30.00 mV	50 Hz	29.70	________	30.30
300.0 mV	50 Hz	297.0	________	303.0
3.000 V	50 Hz	2.970	________	3.030
30.00 V	50 Hz	29.70	________	30.30
300.0 V	50 Hz	297.0	________	303.0
1.000 mV	1000 Hz	0.990	________	1.010
3.000 mV	1000 Hz	2.970	________	3.030
30.00 mV	1000 Hz	29.70	________	30.30
300.0 mV	1000 Hz	297.0	________	303.0
3.000 V	1000 Hz	2.970	________	3.030
30.00 V	1000 Hz	29.70	________	30.30
300.0 V	1000 Hz	297.0	________	303.0
1.000 mV	50000 Hz	0.990	________	1.010
3.000 mV	50000 Hz	2.970	________	3.030
30.00 mV	50000 Hz	29.70	________	30.30
300.0 mV	50000 Hz	297.0	________	303.0
3.000 V	50000 Hz	2.970	________	3.030

TABLE 5-5. AC LEVEL FLATNESS TEST RECORD.

AC CALIBRATOR		ANALYZER AC RATIO MEASUREMENT			
LEVEL	FREQUENCY	SPCL	MINIMUM	ACTUAL	MAXIMUM
1.000 mV	10 Hz		98.00	____________	102.00
1.000 mV	20 Hz		99.00	____________	101.00
1.000 mV	50 Hz		99.50	____________	100.50
1.000 mV	50000 Hz		99.50	____________	100.50
1.000 mV	100000 Hz		99.00	____________	101.00
3.000 mV	10 Hz		98.00	____________	102.00
3.000 mV	20 Hz		99.00	____________	101.00
3.000 mV	50 Hz		99.50	____________	100.50
3.000 mV	50000 Hz		99.50	____________	100.50
3.000 mV	100000 Hz		99.00	____________	101.00
50.00 mV	10 Hz		98.00	____________	102.00
50.00 mV	20 Hz		99.00	____________	101.00
50.00 mV	50 Hz		99.50	____________	100.50
50.00 mV	50000 Hz		99.50	____________	100.50
50.00 mV	100000 Hz		99.00	____________	101.00
150.0 mV	10 Hz		98.00	____________	102.00
150.0 mV	20 Hz		99.00	____________	101.00
150.0 mV	50 Hz		99.50	____________	100.50
150.0 mV	50000 Hz		99.50	____________	100.50
150.0 mV	100000 Hz		99.00	____________	101.00
3.000 V	10 Hz	28	98.00	____________	102.00
3.000 V	20 Hz	28	99.00	____________	101.00
3.000 V	50 Hz	28	99.50	____________	100.50
3.000 V	50000 Hz	28	99.50	____________	100.50
3.000 V	100000 Hz	28	99.00	____________	101.00
3.000 V	50000 Hz	27	99.50	____________	100.50
3.000 V	100000 Hz	27	99.00	____________	101.00
3.000 V	50000 Hz	26	99.50	____________	100.50
3.000 V	100000 Hz	26	99.00	____________	101.00

TABLE 5-6. FREQUENCY ACCURACY TEST RECORD.

SOURCE OSCILLATOR	ANALYZER FREQUENCY MEASUREMENT ERROR		
FREQUENCY	MINIMUM	PASS/FAIL	MAXIMUM
190.000 Hz	-0.001 Hz	PASS FAIL	+0.001 Hz
1900.00 Hz	-0.01 Hz	PASS FAIL	+0.01 Hz
19000.0 Hz	-0.1 Hz	PASS FAIL	+0.1 Hz
140000 Hz	-1 Hz	PASS FAIL	+1 Hz

TABLE 5-7 FILTER ACCURACY TEST RECORD.

FILTER	ANALYZER FREQUENCY MEASUREMENT		
	MINIMUM	PASS/FAIL	MAXIMUM
30 kHz Low-pass	28 kHz	PASS FAIL	32 kHz
80 kHz Low-pass	76 kHz	PASS FAIL	84 kHz
220 kHz Low-pass	200 kHz	PASS FAIL	240 kHz
400 Hz High-pass	360 Hz	PASS FAIL	440 Hz
AUDIO Band-pass	21.28 Hz	PASS FAIL	23.52 Hz
	21.28 kHz	PASS FAIL	23.52 kHz

TABLE 5-8. RESIDUAL DISTORTION AND NOISE TEST RECORD.

AUDIO OSCILLATOR		DISTORTION MEASUREMENT		
LEVEL	**FREQUENCY**	**BW**	**PASS/FAIL**	**MAXIMUM**
3.000 V	10 Hz	80 kHz	PASS FAIL	-80.00 dB
3.000 V	20 Hz	80 kHz	PASS FAIL	-80.00 dB
3.000 V	100 Hz	80 kHz	PASS FAIL	-80.00 dB
3.000 V	1000 Hz	80 kHz	PASS FAIL	-80.00 dB
3.000 V	10000 Hz	80 kHz	PASS FAIL	-80.00 dB
3.000 V	20000 Hz	80 kHz	PASS FAIL	-80.00 dB
3.000 V	50000 Hz	220 kHz	PASS FAIL	-74.00 dB
3.000 V	100000 Hz	500 kHz	PASS FAIL	-65.00 dB
3.000 V	140000 Hz	500 kHz	PASS FAIL	-60.00 dB
200.0 mV	10 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	20 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	100 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	1000 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	10000 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	20000 Hz	80 kHz	PASS FAIL	-80.00 dB
200.0 mV	50000 Hz	220 kHz	PASS FAIL	-74.00 dB
178.0 mV	100000 Hz	500 kHz	PASS FAIL	-65.00 dB
100.0 mV	140000 Hz	500 kHz	PASS FAIL	-60.00 dB

TABLE 5-9. COMMON MODE REJECTION RATIO TEST RECORD.

AUDIO OSCILLATOR		AC LEVEL MEASUREMENT	
LEVEL	FREQUENCY	PASS/FAIL	MAXIMUM
2.000 V	20 Hz	PASS FAIL	-70.00 dB
2.000 V	60 Hz	PASS FAIL	-70.00 dB
2.000 V	1000 Hz	PASS FAIL	-70.00 dB
2.000 V	20000 Hz	PASS FAIL	-40.00 dB

TABLE 5-10. CCITT FILTER ACCURACY TEST RECORD.

ANALYZER CCITT FILTER ACCURACY			
FREQUENCY	MINIMUM	PASS/FAIL	MAXIMUM
50.00 Hz	-65.0	PASS FAIL	-61.0
100.00 Hz	-43.0	PASS FAIL	-39.0
200.00 Hz	-23.0	PASS FAIL	-19.0
300.00 Hz	-11.6	PASS FAIL	-9.6
400.00 Hz	-7.3	PASS FAIL	-5.3
800.00 Hz	-0.2	PASS FAIL	0.2
1000.0 Hz	0.0	PASS FAIL	2.0
1200.0 Hz	-1.0	PASS FAIL	1.0
1600.0 Hz	-2.7	PASS FAIL	-0.7
2000.0 Hz	-4.0	PASS FAIL	-2.0
3000.0 Hz	-6.6	PASS FAIL	-4.6
3500.0 Hz	-10.6	PASS FAIL	-6.5
4000.0 Hz	-18.0	PASS FAIL	-12.0
5000.0 Hz	-39.0	PASS FAIL	-33.0

TABLE 5-11. CCIR, CCIR/ARM FILTER ACCURACY TEST RECORD.

ANALYZER CCIR, CCIR/ARM FILTER ACCURACY					
FREQUENCY	CCIR		PASS/FAIL	CCIR/ARM	
	MINIMUM	MAXIMUM		MINIMUM	MAXIMUM
31.50 Hz	-30.0	-28.0	PASS FAIL	-35.6	-33.6
63.00 Hz	-24.9	-22.9	PASS FAIL	-30.5	-28.5
100.00 Hz	-20.8	-18.8	PASS FAIL	-26.4	-24.4
200.00 Hz	-14.3	-13.3	PASS FAIL	-19.9	-18.9
400.00 Hz	-8.3	-7.3	PASS FAIL	-13.9	-12.9
800.00 Hz	-2.4	-1.4	PASS FAIL	-8.0	-7.0
1000.0 Hz	-0.5	0.5	PASS FAIL	-6.1	-5.1
2000.0 Hz	5.1	6.1	PASS FAIL	-0.5	0.5
3150.0 Hz	8.5	9.5	PASS FAIL	2.9	3.9
4000.0 Hz	10.0	11.0	PASS FAIL	4.4	5.4
5000.0 Hz	11.2	12.2	PASS FAIL	5.6	6.6
6300.0 Hz	12.0	12.4	PASS FAIL	6.4	6.8
7100.0 Hz	11.8	12.2	PASS FAIL	6.2	6.6
8000.0 Hz	11.0	11.8	PASS FAIL	5.4	6.2
9000.0 Hz	9.7	10.5	PASS FAIL	4.1	4.9
10.000 kHz	7.7	8.5	PASS FAIL	2.1	2.9
12.500 kHz	-1.0	1.0	PASS FAIL	-6.6	-4.6
14.000 kHz	-6.3	-4.3	PASS FAIL	-11.9	-9.9
16.000 kHz	-12.7	-10.7	PASS FAIL	-18.3	-16.3
20.000 kHz	-23.2	-21.2	PASS FAIL	-28.8	-26.8
31.500 kHz	-44.7	-40.7	PASS FAIL	-50.3	-46.3

TABLE 5-12. A WEIGHTING FILTER ACCURACY TEST RECORD.

ANALYZER A WEIGHTING FILTER ACCURACY			
FREQUENCY	MINIMUM	PASS/FAIL	MAXIMUM
19.95 Hz	-52.5	PASS FAIL	-48.5
31.62 Hz	-40.9	PASS FAIL	-37.9
50.12 Hz	-31.2	PASS FAIL	-29.2
100.0 Hz	-20.1	PASS FAIL	-18.1
199.5 Hz	-11.9	PASS FAIL	-9.9
316.2 Hz	-7.6	PASS FAIL	-5.6
501.2 Hz	-4.2	PASS FAIL	-2.2
1000.0 Hz	-0.2	PASS FAIL	0.2
1995 Hz	0.2	PASS FAIL	2.2
3162 Hz	0.2	PASS FAIL	2.2
5012 Hz	-1.0	PASS FAIL	2.0
10000 Hz	-4.0	PASS FAIL	-1.0
19950 Hz	-11.3	PASS FAIL	-7.3

TABLE 5-13. B WEIGHTING FILTER ACCURACY TEST RECORD.

ANALYZER B WEIGHTING FILTER ACCURACY			
FREQUENCY	MINIMUM	PASS/FAIL	MAXIMUM
19.95 Hz	-26.2	PASS FAIL	-22.2
31.62 Hz	-18.6	PASS FAIL	-15.6
50.12 Hz	-12.6	PASS FAIL	-10.6
100.0 Hz	-6.6	PASS FAIL	-4.6
199.5 Hz	-3.0	PASS FAIL	-1.0
316.2 Hz	-1.8	PASS FAIL	0.2
501.2 Hz	-1.3	PASS FAIL	0.7
1000.0 Hz	-0.2	PASS FAIL	0.2
1995 Hz	-1.1	PASS FAIL	0.9
3162 Hz	-1.4	PASS FAIL	0.6
5012 Hz	-2.7	PASS FAIL	0.3
10000 Hz	-5.8	PASS FAIL	-2.8
19950 Hz	-13.1	PASS FAIL	-9.1

TABLE 5-14. C WEIGHTING FILTER ACCURACY TEST RECORD.

ANALYZER C WEIGHTING FILTER ACCURACY			
FREQUENCY	MINIMUM	PASS/FAIL	MAXIMUM
19.95 Hz	-8.2	PASS FAIL	-4.2
31.62 Hz	-4.5	PASS FAIL	-1.5
50.12 Hz	-2.3	PASS FAIL	-0.3
100.0 Hz	-1.3	PASS FAIL	0.7
199.5 Hz	-1.0	PASS FAIL	1.0
316.2 Hz	-1.0	PASS FAIL	1.0
501.2 Hz	-1.0	PASS FAIL	1.0
1000.0 Hz	-0.2	PASS FAIL	0.2
1995 Hz	-1.2	PASS FAIL	0.8
3162 Hz	-1.5	PASS FAIL	0.5
5012 Hz	-2.8	PASS FAIL	0.2
10000 Hz	-5.9	PASS FAIL	-2.9
19950 Hz	-13.2	PASS FAIL	-9.2

TABLE 5-15. C-MESSAGE FILTER ACCURACY TEST RECORD.

ANALYZER C-MESSAGE FILTER ACCURACY			
FREQUENCY	**MINIMUM**	**PASS/FAIL**	**MAXIMUM**
60.00 Hz	-57.7	PASS FAIL	-53.7
100.00 Hz	-44.5	PASS FAIL	-40.5
200.00 Hz	-27.0	PASS FAIL	-23.0
300.00 Hz	-17.5	PASS FAIL	-15.5
400.00 Hz	-12.4	PASS FAIL	-10.4
800.00 Hz	-2.5	PASS FAIL	-0.5
1000.0 Hz	-0.2	PASS FAIL	0.2
1200.0 Hz	-1.2	PASS FAIL	0.8
1500.0 Hz	-2.0	PASS FAIL	0.0
2500.0 Hz	-2.4	PASS FAIL	-0.4
3000.0 Hz	-3.5	PASS FAIL	-1.5
3500.0 Hz	-9.6	PASS FAIL	-5.6
4000.0 Hz	-17.5	PASS FAIL	-11.5
5000.0 Hz	-31.5	PASS FAIL	-25.5

5-39. ADJUSTMENTS.

5-40. The Model 1130 adjustments are listed in Table 5-16. Test equipment required for the adjustments is listed in Table 5-1.

5-41. A11 Power Supply Adjustment.

5-42. The power supply has only one adjustment which is the power supply Power Fail Adjustment. The Power Fail Adjustment sets the low line trip level that interrupts the processor operation until the proper AC voltage is applied.

5-43. A11R4 Power Fail Adjustment. Perform the adjustment as follows:

a. Disconnect all power to the Distortion Analyzer and remove the top cover.

b. Set the rear panel line voltage switch to the appropriate voltage.

c. Verify that the line fuse is the proper value as listed on the LINE VOLTAGE SELECT chart located on the rear panel.

d. Connect the variac to an appropriate power source and adjust for a line indication of nominal - 10 % (90, 108, 200 or 216 volts).

WARNING

There are voltages at various points in the instrument which can, if contacted, cause personal injury. Observe all safety precautions.

e. Connect the Distortion Analyzer power cord to the variac and set the LINE ON/OFF switch to ON.

f. Observe the display and adjust A11R4 clockwise until the display just blanks, then slowly counterclockwise until the display returns.

5-44. A5 C.P.U. Adjustment.

5-45. The only adjustment on the C.P.U. Board is the Timebase Frequency Adjustment which is adjusted to provide the specific frequency accuracy for the system time standard.

TABLE 5-16. LIST OF ADJUSTMENTS.

ADJUSTMENT		LOCATION
A11R4	Power Fail	Power Supply Board
A5Y1	Timebase Frequency	C. P. U. Board
A3R57	Notch Balance	Notch Board
A3R58	Notch Tune	Notch Board
A0R29, C35	3 V Range CMRR	Input Board
A0R12	30 V Range CMRR	Input Board
A0R7	300 V Range CMRR	Input Board
A0C5	HI Input 30 V Range Flatness	Input Board
A0C32	HI Input 300 V Range Flatness	Input Board
A0C10	LOW Input 30 V Range Flatness	Input Board
A0C33	LOW Input 300 V Range Flatness	Input Board
A1A32R11	CCIR, CCIR/ARM Cal	CCIR/ARM Filter Board

5-46. A5Y1 Timebase Frequency Adjustment. Perform the procedure as follows:

a. Remove the IEEE-488 interface cable on the C.P.U. Board.

b. Remove the cover screw in the top of A5Y1 to expose the trimmer adjustment.

c. Connect the House Standard frequency reference to the rear panel X CLK input.

d. Set the Option switches A4S1-7 and A4S1-8 to the open position and depress the LCL/INIT key.

e. Observe the FREQUENCY display and adjust A5Y1 until the display indicates 10000.00 kHz + - 1 count.

f. Set the Option switches A4S1-7 and A4S1-8 to the closed position, replace the cover screw and cable.

5-47. A3 Notch Board Adjustments. The Notch Board adjustments consist of A3R57 Notch Balance and A3R58 Notch Tune. These adjustments compensate for offsets in the notch filter which could reduce the effective depth of the notch.

5-48. A3R57 Balance and A3R58 Tune Adjustments.

Perform the adjustments as follows:

a. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument.

b. Connect the Audio Oscillator output HI and LOW to the Analyzer input HI and LOW using the balanced cable and adapters.

c. Connect the Wave Analyzer input to the MONITOR output on the rear panel of the Distortion Analyzer.

d. Set the Wave Analyzer controls as follows:

SCALE	90 dB
FREQUENCY	1 kHz
AMPLITUDE REF LEVEL	NORMAL
INPUT SENSITIVITY	10 dB
RESOLUTION BANDWIDTH	30 Hz
AFC	LOCK
SWEEP MODE	OFF

e. Set the Audio Oscillator level to 3.000 volts and depress the Analyzer DIST key.

f. Observe the Wave Analyzer and alternately adjust A3R57 and A3R58 for a minimum indication. The null measurement should be in excess of 60 dB.

5-49. A0 Input Board Adjustments.

5-50. The Input Board adjustments consist of four common mode rejection adjustments: A0R29 and A0C35 3 V Range CMRR, A0R27 30 V Range CMRR and A0R7 300 V Range CMRR, and four flatness adjustments: A0C5 HI Input 30 V Range Flatness, A0C32 HI Input 300 V Range Flatness, A0C10 LOW Input 30 V Flatness, and A0C33 LOW Input 300 V Flatness.

5-51. A0R29, A0R12, A0R7 and A0C35 CMRR Adjustments.

Perform the adjustments as follows:

a. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument.

b. Enable the Analyzer input float mode and connect the Audio Oscillator HI output to the Analyzer HI and LOW inputs using BNC cables and a TEE adapter.

c. Connect the Wave Analyzer input to the MONITOR output on the rear panel of the Distortion Analyzer.

d. Set the Wave Analyzer controls as follows:

SCALE	90 dB
FREQUENCY	1 kHz
AMPLITUDE REF LEVEL	NORMAL
INPUT SENSITIVITY	0 dB
RESOLUTION BANDWIDTH	30 Hz
AFC	LOCK
SWEEP MODE	OFF

e. Set the Audio Oscillator level to 3.000 volts and enter special function 28.

f. Observe the Wave Analyzer and alternately adjust A0R29 and A0C35 for a minimum indication. The null measurement should be in excess of 75 dB.

g. Enter special function 27.

h. Observe the Wave Analyzer and adjust A0R12 for a minimum indication. The null measurement should be in excess of 75 dB. If a 75 dB null cannot be achieved, alternately adjust A0C5 or A0C10 flatness adjustments and A0R27 for a null in excess of 75 dB.

i. Enter special function 26.

j. Observe the Wave Analyzer and adjust A0R7 for a minimum indication. The null measurement should be in excess of 75 dB. If a 75 dB null cannot be achieved, alternately adjust A0C32 or A0C33 flatness adjustments and A0R7 for a null in excess of 75 dB.

5-52. A0C5 and A0C32 Flatness Adjustments. Perform the adjustments as follows:

a. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument.

b. Enable the Analyzer floating mode and connect the Audio Oscillator output HI and LOW to the Analyzer input HI and LOW, respectively, using the balanced cable and adapters.

c. Set the Audio Oscillator frequency to 100 kHz and level to 3.000 volts.

d. Enter special functions 17 and 28.

e. Depress the RATIO key to enable the Analyzer level ratio mode.

f. Enter special function 27, note the display and adjust A0C5 for an indication of 100.00 % +- 0.1 %.

g. Enter special function 26, note the display and adjust A0C32 for an indication of 100.00 % +- 0.1 %.

5-53. A0C10 and A0C33 Flatness Adjustments. Perform the adjustments as follows:

a. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument.

b. Enable the Analyzer floating mode and connect the Audio Oscillator output HI and LOW to the Analyzer input LOW and HI, respectively, using the balanced cable and adapters.

c. Set the Audio Oscillator frequency to 100 kHz and level to 3.000 volts.

d. Enter special functions 17 and 28.

e. Depress the RATIO key to enable the Analyzer level ratio mode.

f. Enter special function 27, note the display and adjust A0C10 for an indication of 100.00 % +- 0.1 %.

g. Enter special function 26, note the display and adjust A0C33 for an indication of 100.00 % +- 0.1 %.

5-54. A37 CCIR, CCIR/ARM Filter Board Adjustment.

5-55. The CCIR, CCIR/ARM optional filter board adjustment consist of A37R11 Cal. The adjustment sets the high-pass weighting response and is identical for both the CCIR and the CCIR/ARM filter applications.

5-56. A1A32R11 CCIR, CCIR/ARM Cal Adjustment. Perform the adjustment as follows:

a. On the Distortion Analyzer depress the LCL/INIT key to initialize the instrument.

b. Connect the Audio Oscillator output HI and LOW to the Analyzer input HI and LOW using the balanced cable and adapters.

c. Enable the CCIR or CCIR/ARM filter.

d. Set the Audio Oscillator frequency to 6.300 kHz at a level of 3.000 volts.

e. Enable the Analyzer level ratio mode and depress the dB key.

f. Set the Audio Oscillator frequency to 1.000 kHz.

g. Adjust A1A32R11 for a ANALYZER display of -12.20 dB +- 0.05 dB.

h. Set the Audio Oscillator frequency to 6.300 kHz and note the Analyzer ratio measurement. If the display indication is not 0.00 +- 0.05 dB then disable the ratio mode and repeat steps e through h.

5-57. TROUBLESHOOTING.

5-58. Instrument malfunction will generally be evident from front panel indications, or IEEE-488 bus responses. The problems will fall into two general categories: catastrophic failures or selective failure of one subsystem.

5-59. Catastrophic failures would generally cause the Model 1130 to be completely inoperative. For instance, if the microprocessor was not operating properly, the display would contain meaningless symbols and the keyboard would not be responsive. Such failures are usually located in the power supply circuits, interconnecting cables, and the CPU plug-in board.

5-60. Selective failures and performance out of specification are usually limited to one section of the instrument and will be evident from manipulation of the front panel controls. For example, incorrect or erratic distortion measurements will indicate a fault in the notch filter circuits on the Notch Filter plug-in board. Further isolation of the problem requires an

understanding of the simplified block diagrams detailed in the theory of operation section of this manual and experience in troubleshooting analog and digital circuits.

5-61. **TROUBLE LOCALIZATION.**

5-62. The circuits of the Model 1130 are divided into two sections: analyzer circuits and interface circuits. The interface circuits consist of the power supply and digital circuits including the frequency counter, CPU, display, and keyboard.

5-63. **Special Diagnostic Function Codes.** Special function codes 31 through 34 are provided to localize selective failures in the analog and frequency counter circuits. When entered, these codes continuously execute the designated test sequence until the LCL/INIT key is depressed. During the Analyzer level range and counter tests, error codes are reported if a fault is encountered. Table 5-17 lists the ranges, error codes and probable causes to aid in localizing a fault.

5-64. **Counter Plug-in Board Test.** The period counter can be tested using special function 31. In this test sequence the counter is configured to measure the timebase reference. The reference is divided in decade increments from 1 to 10,000 in the period ranging circuits. Each of the five frequency ranges is sequentially checked for accuracy while the ANALYZER display indicates the range being tested. The FREQUENCY display will indicate an error code if a fault is evident on the tested range.

5-65. **Input Plug-in Board Test.** The Input plug-in board can be tested using special function 32. In this test sequence an external signal source set to 1 kHz and 3 volts is required. The HIGH and LOW inputs can be checked by enabling the float mode and connecting the signal source to either input. Each of the seven level ranges is sequentially checked for accuracy while the ANALYZER display indicates the range being tested. The FREQUENCY display will indicate an error code if a fault is evident on the tested range.

5-66. **Filter Plug-in Board Test.** The Filter plug-in board can be tested using special function 33. In this test sequence an external signal source set to 1 kHz and 30 millivolts is applied to the Analyzer input. Each of the five level ranges is sequentially checked for accuracy while the ANALYZER display indicates the range being tested. The FREQUENCY display will indicate an error code if a fault is evident on the tested range.

5-67. **Notch And Detector Plug-in Board Test.** The Notch and Detector plug-in boards can be tested using special function 34. In this test sequence an external signal source set to 1 kHz and 300 millivolts is applied to the Analyzer input. Each of the seven post notch detector ranges is sequentially checked for accuracy while the ANALYZER display indicates the range being tested. The FREQUENCY display will indicate an error code if a fault is evident on the tested range.

TABLE 5-17. DIAGNOSTIC ERROR CODE DESCRIPTIONS.

FAULT	DESCRIPTION	PROBABLE CAUSE
Error 40	Detector board rms conv.	A3U11, A3U13, Q1, A4U20, A4U21
Error 41	Detector average conv.	A3U10, A3U13, Q2, A4U20, A4U21
Error 42	Filter board rms conv.	A1U6, A4U20, A4U21
Error 43	DC full scale	A0U7, A0U4, A0U2, A4U20, A4U21
Error 45	Optional filter No. 2	A1U4, A1U7, A1U8
Error 46	DC offset	A0U7, A0U4, A0U2, A0K4, A0K5, A4U20, A4U21
Error 47	Optional filter No. 1	A1U4, A1U7, A1U8
Error 50	199.999 Hz range	A4U5, A4U9, A4U13
Error 51	1.99999 kHz range	A4U6, A4U9, A4U13
Error 52	19.9999 kHz range	A4U6, A4U9, A4U13
Error 53	199.999 kHz range	A4U7, A4U9, A4U13
Error 54	1999.99 kHz range	A4U7, A4U9, A4U13
All 50-54	Counter accumulator	A4U5, A4U9, A4U10, A4U3, A4U12-16, A5Y1

TABLE 5-17. CONTINUED.

FAULT	DESCRIPTION	PROBABLE CAUSE
Error 60	300 V range	A0K6, A0K7, A0U1
Error 61	150 V range	A0K6, A0K7, A0U1, A0K2, A0U2, A0U6
Error 62	75 V range	A0K6, A0K7. A0U1, A0K1, A0U2, A0U6
Error 63	30 V range	A0K8, A0K9, A0U1,
Error 64	15 V range	A0K8, A0K9, A0U1, A0K2, A0U2, A0U6
Error 65	7.5 V range	A0K8, A0K9, A0U1, A0K1, A0U2, A0U6
Error 66	3.0 V range	A0K1, A0K2, A0U1, A0U2, A0U6
All 60-66	300 - 3 V ranges	A0U4, A0U5, A0U8, A0U9, A0F1, A0F2
Error 67	1500 mV range	A1U1-U4
Error 68	750 mV range	A1U1-U4
Error 69	300 mV range	A1U1-U4
Error 70	150 mV range	A1U1-U4
Error 80	0.1 % range	A3U1-U2, A3U5-U6
Error 81	0.2 % range	A3U1-U2, A3U5-U6
Error 82	0.5 % range	A3U1-U2, A3U5-U6
Error 83	1.0 % range	A3U1-U2, A3U5-U6
Error 84	2.0 % range	A3U2-U4
Error 85	5.0 % range	A3U2-U4
Error 86	10 % range	A3U2-U4
Error 87	20 % range	A2U4, A2U10-U12
Error 88	50 % range	A2U4, A2U10-U12
Error 89	100 % range	A2U4, A2U10-U12
All 80-89	0.1 - 100 % ranges	A3K1, A3U2, A3U8-U13

SECTION VI
PARTS LIST

6-1. INTRODUCTION.

6-2. The replaceable parts for the Model 1130 are listed in Table 6-2. The replaceable parts list contains the reference symbol, description, manufacturer, and both the BEC and manufacturer part numbers. Table 6-1 lists the manufacturer's federal supply code numbers.

TABLE 6-1. MANUFACTURER'S FEDERAL SUPPLY CODE NUMBERS.

01121	Allen Bradley	31918	ITT Schadow, Inc.
01295	Texas Instruments	32293	Intersil, Inc.
02114	Ferroxcube Corp.	32575	AMP
02735	RCA Solid State Division	33297	NEC
03888	Pyrofilm (KDI)	33883	RMC
04222	AVX Ceramics Company	34335	Advanced Micro Devices
04713	Motorola Semiconductor	34371	Harris Semiconductor
04901	Boonton Electronics Corporation	34899	Fair-rite
06383	Panduit Corporation	49956	Raytheon Corporation
06665	Precision Monolithics	51406	Murata Corporation of America
06776	Robinson Nugent, Inc.	51640	Analog Devices, Inc.
07263	Fairchild Semiconductor	54420	Dage - MTI
11961	Semicon	54426	Buss Fuses
13812	Dialco Division of Amperex	54473	Panasonic
14655	Cornell-Dubilier	56289	Sprague Electric Company
14752	Electro Cube, Inc.	56708	Zilog, Inc.
15636	Elec-Trol	57582	Kahgan Electronics Corporation
17856	Siliconix, Inc.	61637	Kemet - Union Carbide
18324	Signetics Corporation	64537	Pyrofilm (KDI)
19505	Applied Eng'r. Products	71450	CTS Corporation
19701	Mepco Electra	73138	Beckman Instruments, Helipot Division
20307	Arco - Micronics	74970	E. F. Johnson
24226	Gowanda Electronics	75915	Littlefuse
27014	National Semiconductor	81073	Grayhill
27264	Molex, Inc.	82389	Switchcraft
27735	F-Dyne Electronics	91293	Johanson
27802	Vectron Labs	91637	Dale Electronics
28480	Hewlett-Packard Corporation	95348	Gordos Corporation
31313	Components Corporation	98291	Sealectro Corporation
31781	EDAC	S4217	United Chemicon, Inc.

TABLE 6-2. REPLACEABLE PARTS LIST.

11200208A PRE CAL ASSEMBLY 1130
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
A0	PWA 1120/30 INPUT	04901	11201600A	1	11201600A
A1	PWA 1120/30 MAIN FILTER	04901	11203500A	1	11203500A
A2	PWA 1130 NOTCH	04901	11302500A	1	11302500A
A3	PWA 1130 DETECTOR	04901	11300000A	1	11300000A
A4	PWA 1130 FREQUENCY COUNTER	04901	11201902A	1	11201902A
A5	PWA 1130 CPU	04901	11202002A	1	11202002A
A8	PWA 8200 EXTENDER	04901	08252300A	1	08252300A
A22	'1130' FRAME ASSEMBLY	04901	11200207A	1	11200207A

11200207A '1130' FRAME ASSEMBLY
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
A11	PWA 1120 POWER SUPPLY	04901	11201400B	1	11201400B
A17	'1130' FRONT PANEL ASSY	04901	11200403A	1	11200403A
A18	CARD CAGE ASSEMBLY 1130	04901	11201202A	1	11201202A
A21	REAR PANEL ASSEMBLY	04901	11200803A	1	11200803A
W14	CABLE ASSY WIRE 22GA 3C 7.00L	04901	57122000A	1	57122000A
W16	CABLE ASSY WIRE 22GA 5C 8.00L	04901	57121900A	1	57121900A
W21	CABLE ASSY FLAT 26CKT 14.75L	04901	92016100A	1	92016100A

11200403A '1130' FRONT PANEL ASSY
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
A13	PWA 1130 KEYBOARD	04901	11201002A	1	11201002A
A23	SUB PANEL ASSY 1130	04901	11200503A	1	11200503A

11200503A SUB PANEL ASSY 1130
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
A12	PWA 1120 DISPLAY	04901	11200900A	1	11200900A
A14	POWER SWITCH ASSEMBLY	04901	11200600A	1	11200600A
A15	BRACKET CONN ASSY (INPUT)	04901	11200701A	1	11200701A

11200600A POWER SWITCH ASSEMBLY
MODEL: 1120

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
S1	SWITCH ROCKER DPDT	13812	572-2121-0103-010	1	465286000
W17/W22	CABLE ASSY WIRE 22/24GA 2/4C L	04901	57123400A	1	57123400A

11200701A BRACKET CONN ASSY (INPUT)
MODEL: 1120

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
J1	CONNECTOR BINDING POST GROUND	74970	111-2223-001	1	479454000A
J2-3	CONN COAX BNC	54420	UG-625/U	2	479123000
W19	CABLE COAXIAL ASSY,INPUT	04901	57223901A	1	57223901A

11201202A CARD CAGE ASSEMBLY 1130
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
A10	FWA 1130 MOTHER	04901	11201502A	1	11201502A

11200803A REAR PANEL ASSEMBLY
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
A19	REAR PANEL UNIT	04901	60335500B	1	60335500B
A20	'1120/30' HEAT SINK ASSY	04901	08250801A	1	08250801A
F1	FUSE 0.75 AMP 250V MDL SLO BLO	54426	MDL-3/4	1	545533000
FL1	FILTER LINE	56289	3JX5421A	1	439004000
J7	CONN COAX BNC	54420	UG-625/U	1	479123000
J9	CONN COAX BNC	54420	UG-625/U	1	479123000
T1	TRANSFORMER POWER	04901	44609600A	1	44609600A
W7	CABLE ASSY COAX RG316/U 16.00L	04901	57223602A	1	57223602A
W9	CABLE ASSY COAX RG316/U 15.00L	04901	57223603A	1	57223603A
W15	CABLE ASSY WIRE 22GA 3C 14.00L	04901	57121701A	1	57121701A
W20	CABLE ASSY, FLAT (GP1B)	04901	57223002A	1	57223002A
W38-39	CABLE ASSY WIRE 20GA 1C 10.50L	04901	57121801A	2	57121801A
W43	CABLE ASSY WIRE 24GA 4C 7.75L	04901	57120100B	1	57120100B

60335500B REAR PANEL UNIT
MODEL: 1120

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
S2	SWITCH DUAL SLIDE DPDT-DPDT	82389	47206LFR	1	465279000

08250801A '1120/30' HEAT SINK ASSY
MODEL: 1120/30

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C20	CAP CER 0.01uF 20% 500V	33883	BGP Z5U W/FDCL	1	224271000
C21	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C22	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
CR1	DIODE BRIDGE SDA-980-1	11961	SDA-980-1	1	532030000
U4	IC 323K REGULATOR	27014	LM323K	1	535024000
U5	IC UA7805UC VOLT REG	07263	uA7805UC	1	53511700A
U6	IC UA79M05AUC VOLT REG	07263	uA79M05AUC	1	535093000
W18	CABLE ASSY WIRE 22GA 3C 5.00L	04901	57121703A	1	57121703A
XU4	SOCKET TRANSISTOR PWR TO-3	06776	MP-3452G	1	47308000A

11201600A PWA 1120/30 INPUT
MODEL: 1120

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1-2	CAPACITOR MATCHED PAIR	04901	23418000A	2	23418000A
C3-4	CAP MICA 20pF 5% 300V	14655	CD5CC200J	2	205017000
C5	CAP VAR CER 5-25pF 250V VIO	91293	9374	1	281021000
C6	CAP CER 8.2pF +-0.5pF 500V	TUSONI	301-000-R2H0-829D	1	224322000
C7-8	CAP MICA 680pF 1% 300V	14655	CD15FC681F03	2	200015000
C9	CAP CER 8.2pF +-0.5pF 500V	TUSONI	301-000-R2H0-829D	1	224322000
C10	CAP VAR CER 5-25pF 250V VIO	91293	9374	1	281021000
C11-12	CAP CER 0.02uF 20% 500V	51406	GP5-203MF	2	224118000
C13-14	CAP MICA 12pF 5% 300V	57582	KD5120J301	2	205005000
C15-16	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C17	CAP MICA 10pF 5% 300V	14655	CD5WCC100J	1	205002000
C18	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C21-22	CAP CER 8.2pF +-0.5pF 500V	TUSONI	301-000-R2H0-829D	2	224322000
C23-24	CAP CER 33pF 5% 1000V	56289	10TCC-Q33	2	224139000
C25	CAP MICA 56pF 5% 300V	14655	CD5EC560J	1	205031000
C26-27	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	2	283334000
C28	CAP MICA 27pF 5% 300V	14655	CD5EC270J	1	205008000
C29	CAP MICA 33pF 5% 300V	20307	DM5-EC330J	1	205010000
C30	CAP MICA 130pF 5% 100V	14655	CD5FA131J	1	205011000
C31	CAP MICA 33pF 5% 300V	20307	DM5-EC330J	1	205010000
C32-33	CAP VAR CER 6-70pF	91293	9315	2	281010000
CR1-6	DIODE SIG 1N914	01295	1N914	6	530058000
CR7-10	DIODE SIG FDH-300	07263	FDH300	4	530052000
CR11-12	DIODE ZENER 1N5230B 4.7V 5%	04713	1N5230B	2	530603000
CR13	DIODE SIG FDH-300	07263	FDH300	1	530052000
F1-2	FUSE 1/16 AMP 220V SLO BLO	54426	MDL 1/16	2	545518000
J19	HEADER 4 PIN STRAIGHT	06383	HPSS156-4-C	1	477344000
K1-2	RELAY FORM "A"	15636	RA3080-1051	2	471033000
K3-9	RELAY REED 15V PSEVDO FORM "C"	WABASH	1632-3-1	7	47104800A
L1-2	INDUCTOR 5.6uH 10%	24226	15/561	2	400308000
L3-4	FERRITE BEADS	34899	2643000101	2	483247000
Q1-6	TRANS NPN 2N3904	04713	2N3904	6	528071000
R1-2	RES COMP 10K 5% 1W	01121	BG1035	2	302125000
R3-4	RES MF 99.00K 0.1% 2W	03888	PME75 T-2	2	32676200A
R5-6	RES NF 1.000K 0.1% 1/8W	03888	PME55-T2	2	324241000
R7	RES VAR 20 OHM 20% 0.5W	73138	72XWR20	1	311397000
R8-9	RES MF 90.00K 0.1% 1/2W	03888	PME65 T-2	2	32676100A
R10-11	RES MF 11.00K 0.1% 1/8W	03888	PME55 T-2	2	32592300A
R12	RES VAR 200 OHM 10% 0.5W	73138	72XWR200	1	311339000
R13-14	RES COMP 10K 5% 1W	01121	BG1035	2	302125000
R15-16	RES MF 100.0K 0.1% 1/2W	03888	PME65 T-2	2	32676300A
R17-18	RES MF 2.000K 0.1% 1/8W	64537	PME55 T-0	2	324275000
R19-21	RES MF 4.000K 0.1% 1/8W	64537	PME55 T-0	3	324313000
R22	RES MF 8.000K 0.1% 1/8W	03888	PME55 T-2	1	32592400A
R23-24	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R25-27	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	3	324326000
R28	RES MF 4.950K 0.1% 1/8W	03888	PME55 T-2	1	32592500A
R29	RES VAR 100 OHM 10% 0.5W	73138	72XWR100	1	311306000
R30	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R31	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	1	324326000
R34-35	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	2	341367000
R36	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	1	341429000
R37-42	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	6	341329000
R43-44	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R45-46	RES COMP 20M 5% 1/4W	01121	CB2065	2	343729000
U1	IC 74LS74 FLIP FLOP	01295	SN74LS74N	1	534157000
U2	IC 74LS273 OCTAL D FLIPFLOP	01295	SN74LS273N	1	534263000
U3	IC 78L05 VOLT REG	07263	uA78L05AWC	1	535044000
U4	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U5	IC 5534AN OP AMP	18324	NE553AN	1	535061000
U6	IC 339 QUAD COMPARATOR	27014	LM339N	1	535018000
U7	IC TL072BCP DUAL OP AMP	01295	TL072BCP	1	535102000
U8-9	IC 5534AN OP AMP	18324	NE553AN	2	535061000
XF1-4	FUSE CLIP	54426	1A-1119-10	4	482110000
XU1	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU2	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU4	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU5	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU6	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU7-9	SOCKET IC 8 PIN	06776	ICN-083-S3-G	3	473041000

11203500A PWA 1120/30 MAIN FILTER
MODEL: 1120/30

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1-2	CAP EL 100uF 20% 25V	54217	SM-25-VB-100-M	2	283334000
C3	CAP MICA 10pF 5% 300V	14655	CD5WCC100J	1	205002000
C4-6	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C7	CAP TANT 2.2uF 20% 35V	61637	T368B225M035ASC2513	1	283317000
C8	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C9	CAP MICA 20pF 5% 300V	14655	CD5CC200J	1	205017000
C10-11	CAP EL 100uF 20% 25V	54217	SM-25-VB-100-M	2	283334000
C12	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
CR1-3	DIODE SIG 1N914	01295	1N914	3	530058000
CR4	DIODE ZENER 1N5227B 3.6V 5%	04713	1N5227B	1	530095000
L1-2	INDUCTOR 5.6uH 10%	24226	10/561	2	400408000
P1A-10A	SOCKET SPRING COMPONENT LEAD	32575	1-332070-7	10	479333000
P1B-10B	SOCKET SPRING COMPONENT LEAD	32575	1-332070-7	10	479333000
R1	RES MF 4.02K 1% 1/4W	19701	5043ED4K020F	1	341358000
R2	RES MF 3.000K 0.1% 1/8W	64537	PME55-T2	1	324300000
R3-4	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	2	324241000
R5-6	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	2	341329000
R7	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
U1	IC 5534AN OP AMP	18324	NE553AN	1	535061000
U2	IC 13201N ANALOG SWITCH	27014	LF13201N	1	535106000
U3	IC 74LS273 OCTAL D FLIPFLOP	01295	SN74LS273N	1	534263000
U4	IC 74LS139 DECODE/MULTPXR	01295	SN74LS139N	1	534188000
U5	IC HA3-2625-5-M OP AMP	34371	HA3-2625-5	1	53511900A
U6	IC AD536 TRUE RMS/DC CONV	51640	AD536AJD	1	535105000
U7	IC 13201N ANALOG SWITCH	27014	LF13201N	1	535106000
U8	IC 5534AN OP AMP	18324	NE553AN	1	535061000
U9	IC 78L05 VOLT REG	07263	uA78L05AWC	1	535044000
XU1	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU2	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU3	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU4	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU5	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU6	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU7	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU8	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000

11302500A PWA 1130 NOTCH
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1-2	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C3	CAP MICA 430pF 1% 500V	14655	CD15FD431F03	1	200037000
C4	CAP MPC 0.47uF 1% 50V	27735	MPC-53-0.47-50-1	1	23417500A
C5	CAP MPC 0.047uF 1% 50V	27735	MPC-53-.047-50-1	1	23417400A
C6	CAP MICA 8200pF 1% 100V	14655	CD19FA822F	1	200532000
C7	CAP MICA 680pF 1% 300V	14655	CD15FC681F03	1	200015000
C8-9	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C10	CAP MICA 430pF 1% 500V	14655	CD15FD431F03	1	200037000
C11	CAP MPC 0.47uF 1% 50V	27735	MPC-53-0.47-50-1	1	23417500A
C12	CAP MPC 0.047uF 1% 50V	27735	MPC-53-.047-50-1	1	23417400A
C13	CAP MICA 8200pF 1% 100V	14655	CD19FA822F	1	200532000
C14	CAP MICA 680pF 1% 300V	14655	CD15FC681F03	1	200015000
C15	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C16-17	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	2	283334000
C18-19	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	2	283228000
C20-21	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C22-23	CAP CER 0.02uF 20% 500V	51406	GP5-203MF	2	224118000
C24	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C25	CAP MPC 0.033uF 2% 50V	27735	MPC-53-0.033-50-2	1	23417600A
C26	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C27	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	1	234139000
C28-29	CAP MPC 0.33uF 10% 100V	19701	719B1GD334PK101SB	2	234162000
C30	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	1	234139000
C31	CAP MPC 0.033uF 2% 50V	27735	MPC-53-0.033-50-2	1	23417600A
C32	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C33	CAP MICA 8.0pF 10% 300V	57582	KD5080D301	1	205001000
C34	CAP MICA 5.0pF 10% 300V	14655	CD5CC050D	1	205000000
CR1-6	DIODE SIG 1N914	01295	1N914	6	530058000
J1	HEADER 3 PIN STRAIGHT	06383	MFSS100-3-C-A	1	477364000
L1-2	INDUCTOR 5.6uH 10%	24226	10/561	2	400408000
P1	SHUNT 2 CIRCUIT	27264	15-38-1024	1	483253000
Q1-24	TRANS FET J108	17856	J-108	24	52815600A
Q25-26	TRANS FET PN4391	27014	PN4391	2	52815900A
Q27-28	TRANS FET J108	17856	J-108	2	52815600A
R1-2	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	2	341429000
R3	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R4	RES MF 8.25K 1% 1/4W	19701	5043ED8K250F	1	341388000
R5	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R6	RES MF 40.00K 0.1% 1/8W	03888	PME55 TO	1	32591900A
R7	RES MF 20.00K 0.1% 1/8W	03888	PME55 TO	1	32591800A
R8	RES MF 10.00K 0.1% 1/8W	91637	CMF55-1002-B-T2	1	32593100A
R9	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	1	324326000
R10	RES MF 40.00K 0.1% 1/8W	03888	PME55 TO	1	32591900A
R11	RES MF 20.00K 0.1% 1/8W	03888	PME55 TO	1	32591800A
R12	RES MF 10.00K 0.1% 1/8W	91637	CMF55-1002-B-T2	1	32593100A
R13	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	1	324326000
R14-18	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	5	341367000
R19	RES MF 40.00K 0.1% 1/8W	03888	PME55 TO	1	32591900A
R20	RES MF 20.00K 0.1% 1/8W	03888	PME55 TO	1	32591800A
R21	RES MF 10.00K 0.1% 1/8W	91637	CMF55-1002-B-T2	1	32593100A
R22	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	1	324326000
R23	RES MF 40.00K 0.1% 1/8W	03888	PME55 TO	1	32591900A
R24	RES MF 20.00K 0.1% 1/8W	03888	PME55 TO	1	32591800A
R25	RES MF 10.00K 0.1% 1/8W	91637	CMF55-1002-B-T2	1	32593100A
R26	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	1	324326000
R27	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R28	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R29	RES NTWK 3.3K 2% 0.9W (6 PIN)	71450	750-61-R3.3K	1	34504500A
R30	RES NTWK 3.3K 2% 1.5W (10 PIN)	71450	750-101-R3.3K	1	345030000
R31-32	RES MF 100K 1% 1/4W	19701	5043ED100K0F	2	341500000
R33	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	1	324241000
R34	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R35	RES MF 9.000K 0.1% 1/4W	64537	PME55-T2	1	324354000
R36	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R37-40	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	4	341367000
R41	RES MF 24.9K 1% 1/4W	19701	RN55D-2492-F	1	341438000
R42-43	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	2	341346000
R44	RES MF 24.9K 1% 1/4W	19701	RN55D-2492-F	1	341438000
R45-46	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R47	RES MF 30.1K 1% 1/4W	19701	5043ED30K10F	1	341446000
R48-49	RES MF 66.5K 1% 1/4W	19701	5043ED66K50F	2	341479000
R50	RES MF 30.1K 1% 1/4W	19701	5043ED30K10F	1	341446000

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REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
R51	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R52	RES MF 10.0 OHM 1% 1/4W	19701	5043ED10R00F	1	341100000
R53	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R54	RES MF 10.0 OHM 1% 1/4W	19701	5043ED10R00F	1	341100000
R55-56	RES MF 100K 1% 1/4W	19701	5043ED100K0F	2	341500000
R57-58	RES VAR 20K 10% 0.5W	73138	82PAR20K	2	311374000
R59-60	RES MF 49.9K 1% 1/4W	19701	5043ED49K90F	2	341467000
R61	RES NETWORK 100K 2% 1.5W	71450	750-61-R100K	1	345032000
R62-63	RES MF 80.6K 1% 1/4W	19701	5043ED80K60F	2	341487000
R64-65	RES MF 100K 1% 1/4W	19701	5043ED100K0F	2	341500000
R66	RES NETWORK 100K 2% 1.5W	71450	750-61-R100K	1	345032000
R67-68	RES MF 49.9K 1% 1/4W	19701	5043ED49K90F	2	341467000
R69-70	RES MF 33.2K 1% 1/4W	19701	5043ED33K20F	2	341450000
R71	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	1	341429000
R72	RES MF 49.9K 1% 1/4W	19701	5043ED49K90F	1	341467000
R73	RES MF 102 OHM 1% 1/4W	19701	5043ED102R0F	1	341201000
R74	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R75	RES MF 102 OHM 1% 1/4W	19701	5043ED102R0F	1	341201000
R76	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
U1-3	IC 5532 OP-AMP	18324	NE5532AN	3	53513500A
U4-5	IC 74LS273 OCTAL D FLIPFLOP	01295	SN74LS273N	2	534263000
U6-8	IC 339 QUAD COMPARATOR	27014	LM339N	3	535018000
U9	IC 78L05 VOLT REG	07263	uA78L05AWC	1	535044000
U10	IC HA3-2625-5-M OP AMP	34371	HA3-2625-5	1	53511900A
U11	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U12	IC 5532 OP-AMP	18324	NE5532AN	1	53513500A
U13	IC 393 OP AMP	27014	LM393N	1	535107000
U14	IC OP-07EP OP AMP	06665	OP-07EP	1	535110000
U15	IC 13201N ANALOG SWITCH	27014	LF13201N	1	535106000
U16	IC OP-07EP OP AMP	06665	OP-07EP	1	535110000
U17-18	IC 4200ADE ANALOG MULTIPLIER	49956	RC4200ADE	2	53508301A
XU1-3	SOCKET IC 8 PIN	06776	ICN-083-S3-G	3	473041000
XU4-5	SOCKET IC 20 PIN	06776	ICN-203-S3-G	2	473065000
XU6-8	SOCKET IC 14 PIN	06776	ICN-143-S3-G	3	473019000
XU10	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU11	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU12-14	SOCKET IC 8 PIN	06776	ICN-083-S3-G	3	473041000
XU15	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU16-18	SOCKET IC 8 PIN	06776	ICN-083-S3-G	3	473041000

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REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	1	283228000
C2	CAP TANT 15uF 10% 20V	56289	196D156X9020KA1	1	283227000
C3	CAP MICA 3.0pF +-0.5pF 300V	14655	CD5CC030D	1	205013000
C4	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	1	283228000
C5-6	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C7	CAP MICA 3.0pF +-0.5pF 300V	14655	CD5CC030D	1	205013000
C8	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C9	CAP MICA 500pF 1% 500V	14655	CD15FD501F	1	200123000
C11	CAP MICA 130pF 5% 100V	14655	CD5FA131J	1	205011000
C12	CAP MICA 500pF 1% 500V	14655	CD15FD501F	1	200123000
C13	CAP MICA 250pF 1% 50V	14655	CD5FY251F	1	205034000
C14	CAP MICA 56pF 1% 300V	57582	KD5560F301	1	205053000
C15	CAP MICA 91pF 1% 300V	14655	CD5FC910F	1	205033000
C16	CAP MICA 47pF 1% 300V	57582	KD5470F301	1	205052000
C17	CAP MICA 15pF 5% 300V	14655	CD5CC150J	1	205035000
C18	CAP MICA 120pF 1% 50V	20307	DM5-FY121F	1	205050000
C19	CAP MICA 68pF 1% 300V	14655	CD5EC680F	1	20506001A
C20-21	CAP MPC 0.22uF 2% 50V	14752	652A-1-A224G	2	234167000
C22	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	1	283228000
C23-24	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C25	CAP TANT 2.2uF 20% 35V	61637	T368B225M035ASC2513	1	283317000
C26-31	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	6	224268000
C32	CAP EL 6.8uF 10% 35V	56289	196D685X9035KA1	1	283217000
C33-34	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C35	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C36-39	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	4	224268000
C40-41	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	2	283334000
C42	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C43	CAP MICA 27pF 5% 300V	14655	CD5EC270J	1	205008000
C44	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	1	283228000
CR1-5	DIODE SIG 1N914	01295	1N914	5	530058000
CR6-7	DIODE ZENER 1N5230B 4.7V 5%	04713	1N5230B	2	530103000
CR8-9	DIODE SIG 1N914	01295	1N914	2	530058000
CR10-11	DIODE SIG 5082-2835	28480	5082-2835	2	530167000
CR12	DIODE ZENER 1N5240B 10V 5%	04713	1N5240B	1	530077000
K1	RELAY DIP DPST 5V FORM "C"	95348	835C-1	1	471034000
L1-2	INDUCTOR 5.6uH 10%	24226	10/561	2	400408000
Q1-2	TRANS FET PN4391	27014	PN4391	2	52815900A
R1-2	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R3	RES MF 9.000K 0.1% 1/4W	64537	PME55-T2	1	324354000
R4-5	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	2	324241000
R6	RES MF 9.000K 0.1% 1/4W	64537	PME55-T2	1	324354000
R7	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	1	324326000
R8	RES MF 3.000K 0.1% 1/8W	64537	PME55-T2	1	324300000
R9-11	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	3	324241000
R12	RES MF 9.000K 0.1% 1/4W	64537	PME55-T2	1	324354000
R13	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R14	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R15	RES MF 13.3K 1% 1/4W	19701	5043ED13K30F	1	341412000
R16	RES MF 19.6K 1% 1/4W	19701	5043ED19K60F	1	341428000
R17	RES MF 2.43K 1% 1/4W	19701	RN55D-2431-F	1	341337000
R18	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R19	RES MF 14.0K 1% 1/4W	19701	5043ED14K00F	1	341414000
R20	RES MF 2.43K 1% 1/4W	19701	RN55D-2431-F	1	341337000
R21	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R22	RES MF 11.5K 1% 1/4W	19701	5043ED11K50F	1	341406000
R23	RES MF 2.43K 1% 1/4W	19701	RN55D-2431-F	1	341337000
R24	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R25	RES MF 374K 1% 1/4W	19701	5043ED374K0F	1	341555000
R26	RES MF 105K 1% 1/4W	19701	5043ED105K0F	1	341502000
R27	RES MF 604 OHM 1% 1/4W	19701	5043ED604R0F	1	341275000
R29	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R30	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R31	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R32	RES MF 6.19K 1% 1/4W	19701	5043ED6K190F	1	341376000
R33	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R34	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R35	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R36	RES MF 140K 1% 1/4W	19701	5043ED140K0F	1	341514000
R37	RES MF 80.6K 1% 1/4W	19701	5043ED80K60F	1	341487000
R38-39	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	2	341367000
R40	RES MF 140K 1% 1/4W	19701	5043ED140K0F	1	341514000

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REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
R41-42	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	2	341367000
R43	RES MF 17.8K 1% 1/4W	19701	5043ED17K80F	1	341424000
TP1-8	TERMINAL WIRE LOOP TEST POINT	31313	TP-103-02	8	48330600A
U1	IC 78L05 VOLT REG	07263	uA78L05AWC	1	535044000
U2	IC 74LS273 OCTAL D FLIPFLOP	01295	SN74LS273N	1	534263000
U3	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U4	IC HA3-2625-5-M OP AMP	34371	HA3-2625-5	1	53511900A
U5	IC 13201N ANALOG SWITCH	27014	LF13201N	1	535106000
U6	IC 74LS139 DECODE/MULTPXR	01295	SN74LS139N	1	534188000
U7	IC HA3-2625-5-M OP AMP	34371	HA3-2625-5	1	53511900A
U8	IC 13201N ANALOG SWITCH	27014	LF13201N	1	535106000
U9	IC 5532A DUAL OP AMP 8 DIP	01295	NE5532AP	1	53512100A
U10	IC TL072BCP DUAL OP AMP	01295	TL072BCP	1	535102000
U11	IC AD536 TRUE RMS/DC CONV	51640	AD536AJD	1	535105000
U12	IC 393 OP AMP	27014	LM393N	1	535107000
U13	IC TL072BCP DUAL OP AMP	01295	TL072BCP	1	535102000
XU2	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU3	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU4	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU5-6	SOCKET IC 16 PIN	06776	ICN-163-S3-G	2	473042000
XU7	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU8	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU9-10	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000
XU11	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU12-13	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000

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PWA 1130 FREQUENCY COUNTER

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C2	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C3-9	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	7	224268000
C10-12	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	3	283334000
C13	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C14	CAP MPC 0.0022uF 2% 50V	14752	653A-1-A222G	1	234165000
C15	CAP CER 3900pF 10% 100V	61637	C052K392K1X5CA	1	224319000
C16	CAP CER 560pF 10% 200V	61637	C052K561K2X5CA	1	224290000
C17	CAP TANT 4.7uF 10% 10V	56289	196D475X9010HA1	1	283226000
C18-22	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	5	224268000
C23	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C24	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C25	CAP MICA 250pF 5% 50V	57582	KD251J101	1	205037000
C26-27	CAP TANT 2.2uF 20% 35V	61637	T368B225M035ASC2513	2	283317000
CR1-9	DIODE SIG 1N914	01295	1N914	9	530058000
CR10-11	DIODE SIG FDH-300	07263	FDH300	2	530052000
CR12-13	DIODE SIG 1N914	01295	1N914	2	530058000
CR14	DIODE ZENER 1N5231B 5.1V 5%	04713	1N5231BSZ	1	530169000
DS1	LED RED DIFF 5082-4684	28480	HLMP-1301	1	536024000
DS2-5	LED RED DIFF HLMP-6620	28480	HLMP-6620	4	536026000
L1	INDUCTOR VK200/19-4B	02114	VK200/19-4B	1	400410000
L2-3	INDUCTOR 5.6uH 10%	24226	15/561	2	400308000
R1	RES MF 215 OHM 1% 1/4W	19701	5043ED215R0F	1	341232000
R2	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R3	RES MF 499 OHM 1% 1/4W	19701	5043ED499R0F	1	341267000
R4	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R5	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R6-7	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R8-9	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R10	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R11	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R12	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R13	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R14	RES NETWORK 3K/6.2K 2% 2.7W	73138	785-5-R3K/6.2K	1	345031000
R15-19	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	5	341367000
R20-21	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	2	341346000
R22-23	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R24	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R25-26	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R27	RES MF 56.2K 1% 1/4W	19701	5043ED56K20F	1	341472000
R28	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	1	324326000
R29	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
S1	SWITCH ROCKER (8 SW)	81073	76SB08S	1	465283000
TP1-12	TERMINAL WIRE LOOP TEST POINT	31313	TP-103-02	12	48330600A
U1	IC 393 OP AMP	27014	LM393N	1	535107000
U2	IC 74LS04 HEX INVERTER	01295	SN74LS04N	1	534155000
U3-4	IC 74LS00 2 INP POS NAND	01295	SN74LS00N	2	534167000
U5	IC 74F151PC	07263	74F151PC	1	534374000
U6-8	IC 74LS490 DUAL DEC COUNTER	18324	N74LS490N	3	534238000
U9	IC 74F151PC	07263	74F151PC	1	534374000
U10	IC 74F74PC DUAL D FLIP FLOP	07263	74F74PC	1	534367000
U11	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
U12	IC 74F74PC DUAL D FLIP FLOP	07263	74F74PC	1	534367000
U13-14	IC 8255APC PERIPH INTERFACE	34335	AM8255APC	2	534171000
U15-16	IC 4040B COUNTER/DIVIDER	02735	CD4040BE	2	534275000
U17	IC 393 OP AMP	27014	LM393N	1	535107000
U20	IC REF-02-CZ 5 VOLT REFERENCE	06665	PMI REF-12CZ	1	53512900A
U21	IC AD7582KN 12 BIT A/D	24355	AD7582KN	1	53512800A
XS1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU1	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU2-4	SOCKET IC 14 PIN	06776	ICN-143-S3-G	3	473019000
XU5-9	SOCKET IC 16 PIN	06776	ICN-163-S3-G	5	473042000
XU10	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU11	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU12	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU13-14	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	2	473052000
XU15-16	SOCKET IC 16 PIN	06776	ICN-163-S3-G	2	473042000
XU17-18	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000
XU19	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU20	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU21	SOCKET IC 28 PIN	06776	ICN-286-S4-TG	1	473044000

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REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
B1	CELL LITHIUM 3V	54473	BR2325-1HB	1	556007000
C1-6	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	6	224268000
C7	CAP TANT 15uF 10% 20V	56289	196D156X9020KA1	1	283227000
C8-9	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C10	CAP TANT 15uF 10% 20V	56289	196D156X9020KA1	1	283227000
C11-15	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	5	224268000
C16	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
CR1-3	DIODE SIG 1N914	01295	1N914	3	530058000
J20-21	SOCKET IC 24 PIN	06776	ICN-246-S4-G	2	473043000
L1	INDUCTOR VK200/19-4B	02114	VK200/19-4B	1	400410000
Q1	TRANS NPN 2N3904	04713	2N3904	1	528071000
R1	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R2	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R3	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R4	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R5	RES MF 22.1K 1% 1/4W	19701	RN55D-2212-F	1	341433000
R6	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R7	RES NETWORK 3K/6.2K 2% 1.5W	73138	783-5-R3K/6.2K	1	345033000
R8-9	RES NETWORK 3K/6.2K 2% 2.7W	73138	785-5-R3K/6.2K	2	345031000
U1	IC 74LS04 HEX INVERTER	01295	SN74LS04N	1	534155000
U2	IC 74LS32 QUAD 2 INPUT OR	01295	SN74LS32N	1	534168000
U3-4	IC 8304BN 8 BIT TRI ST TRANS	27014	DP8304BN	2	534251000
U5	IC 4066A CMOS BILAT SW	02735	CD4066AE	1	534078000
U6	IC 4023B COS/MOS NAND	02735	CD4023AE	1	534143000
U7	IC Z80 MICROPRCS 6 MHz CMOS	56708	Z84C00-06PE	1	53440906A
U8-10	IC 74LS541 OCTAL BUFFER	01295	SN74LS541N	3	534381000
U11	IC 5564 8Kx8 RAM CMOS 28 DIP	TOSHIB	TC5564PL-15	1	534403000
U12	IC 74LS32 QUAD 2 INPUT OR	01295	SN74LS32N	1	534168000
U13	IC 74F74PC DUAL D FLIP FLOP	07263	74F74PC	1	534367000
U14	PROM 1130 A5 U14 CPU PWA	04901	53447200A	1	53447200A
U15	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
U16	IC 9914ANL IEEE BUS PROCESSOR	01295	TMS9914ANL	1	534288000
U17	IC 75160 IEEE BUS TRANSCEIVER	01295	SN75160BN	1	534286000
U18	IC 75161 IEEE BUS TRANSCEIVER	01295	SN75161BN	1	534287000
XU1-2	SOCKET IC 14 PIN	06776	ICN-143-S3-G	2	473019000
XU3-4	SOCKET IC 20 PIN	06776	ICN-203-S3-G	2	473065000
XU5-6	SOCKET IC 14 PIN	06776	ICN-143-S3-G	2	473019000
XU7	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	1	473052000
XU8-10	SOCKET IC 20 PIN	06776	ICN-203-S3-G	3	473065000
XU11	SOCKET IC 28 PIN	06776	ICN-286-S4-TG	1	473044000
XU12-13	SOCKET IC 14 PIN	06776	ICN-143-S3-G	2	473019000
XU14	SOCKET IC 28 PIN	06776	ICN-286-S4-TG	1	473044000
XU15	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU16	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	1	473052000
XU17-18	SOCKET IC 20 PIN	06776	ICN-203-S3-G	2	473065000
Y1	OSC CRYSTAL 10 MHz	27802	CO-251-B16	1	547904000

11201400B FWA 1120 POWER SUPPLY
MODEL: 1120/1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1-2	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	2	224364000
C4	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	1	224364000
C5-7	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	3	283293000
C8	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C9	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C10-12	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C13	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C14	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C15	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C16-17	CAP EL 4500uF 20% 35V	56289	622D452M035AA2A	2	283339000
C18	CAP EL 26000uF 20% 16V	56289	622D263M016AC2A	1	283340000
CR3-4	DIODE ZENER 1N5242B 12V 5%	04713	1N5242B	2	530146000
CR5-6	DIODE SIG 1N4001	04713	1N4001	2	530151000
CR7	DIODE BRIDGE FWLD-50	11961	FWLA-50	1	532028000
CR8-11	DIODE SIG 1N4001	04713	1N4001	4	530151000
J14	HEADER 5 PIN STRAIGHT	06383	MPSS156-5-D	1	477345000
J15	HEADER 3 PIN STRAIGHT .156 SPA	06383	HPSS156-3-C	1	477343000
J16	HEADER 5 PIN STRAIGHT	06383	MPSS156-5-D	1	477345000
J17	HEADER 2 PIN STRAIGHT	06383	HPSS156-2-C	1	477342000
J18	HEADER 3 PIN STRAIGHT .156 SPA	06383	HPSS156-3-C	1	477343000
R1	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R2-3	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R4	RES MF 200K 1% 1/4W	19701	5043ED200K0F	1	341529000
R5	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R6	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R7	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R8	RES MF 301 OHM 1% 1/4W	19701	5043ED301R0F	1	341246000
R9	RES VAR 1K 10% 0.5W	73138	72PR1K	1	311316000
R10	RES NTWK 10K 0.1% 1.5W 16-DIP	73138	698-3R10KD	1	345010000
U1	IC 339 QUAD COMPARATOR	27014	LM339N	1	535018000
U2	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
U3	IC REF-01CP VOLTAGE REFERENCE	06665	REF-01CP	1	535116000
U4	IC 78L05 VOLT REG	07263	uA78L05AWC	1	535044000
W36	CABLE ASSY WIRE 22GA 2C 6.50L	04901	571206000	1	571206000
W41	CABLE ASSY WIRE 24GA 3C 4.50L	04901	571204000	1	571204000
W42	CABLE ASSY WIRE 24GA 3C 4.50L	04901	571203000	1	571203000
XR10	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU1	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU2-3	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000

11201002A FWA 1130 KEYBOARD
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
J1-2	WIRE,BARE,SOLID 24 AWG	04901	920148240	2	920148240
J33A-33B	CONNECTOR 17 PIN (F)	27264	22-02-2175	1	47945617A
J34	CONNECTOR 20 PIN	27264	22-02-2205	1	479399000
S1	SWITCH PUSH BUTTON W/O LED	31918	200330	1	465294000
S2	SWITCH PUSH BUTTON W/LED	31918	200480	1	465293000
S4	SWITCH PUSH BUTTON W/LED	31918	200480	1	465293000
S5-9	SWITCH PUSH BUTTON W/O LED	31918	200330	5	465294000
S10-12	SWITCH PUSH BUTTON W/LED	31918	200480	3	465293000
S13-17	SWITCH PUSH BUTTON W/O LED	31918	200330	5	465294000
S18-19	SWITCH PUSH BUTTON W/LED	31918	200480	2	465293000
S20-24	SWITCH PUSH BUTTON W/O LED	31918	200330	5	465294000
S25-26	SWITCH PUSH BUTTON W/LED	31918	200480	2	465293000
S27-30	SWITCH PUSH BUTTON W/O LED	31918	200330	4	465294000
S32-33	SWITCH PUSH BUTTON W/LED	31918	200480	2	465293000
S34-37	SWITCH PUSH BUTTON W/O LED	31918	200330	4	465294000
S39	SWITCH PUSH BUTTON W/LED	31918	200480	1	465293000
S45	SWITCH PUSH BUTTON W/LED	31918	200480	1	465293000
S48	SWITCH PUSH BUTTON W/LED	31918	200480	1	465293000
S50-52	SWITCH PUSH BUTTON W/LED	31918	200480	3	465293000

11200900A PWA 1120 DISPLAY
MODEL: 1120

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1-11	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	11	224268000
C12	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C13-16	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	4	224268000
C17	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
DS1-6	DISPLAY NUMERIC 5082-7651	28480	5082-7651	6	536811000
DS7-8	LED LIGHT BAR MOD HLMP-2620	28480	HLMP-2620	2	536027000
DS9-16	DISPLAY NUMERIC 5082-7651	28480	5082-7651	8	536811000
DS17-19	LED LIGHT BAR MOD HLMP-2620	28480	HLMP-2620	3	536027000
DS20-21	DISPLAY NUMERIC 5082-7651	28480	5082-7651	2	536811000
DS22	LED LIGHT BAR MOD HLMP-2620	28480	HLMP-2620	1	536027000
J31	CONNECTOR HEADER 2 PIN RT ANLE	06383	HPAS156-2-C	1	477385000
J32	CONN M 26 CKT RT ANGLE 3 WALL	06776	IDH-26K-SR3-TG30	1	47741326A
P33A-33B	CONNECTOR HEADER 17 PIN	27264	22-03-2171	1	47741117A
P34	CONNECTOR 20 PIN STRAIGHT	27264	22-03-2201	1	477397000
R1	RES NETWORK 22 OHM +-2 OHM 2W	01121	316B-220	1	345034000
R2-3	RES NETWORK 3K/6.2K 2% 2.7W	73138	785-5-R3K/6.2K	2	345031000
R4-6	RES NETWORK 150 OHM 2% 1.5W	73138	898-3-R150	3	345026000
R7-10	RES NETWORK 330 OHM 2% 1.5W	73138	898-3-R330	4	345027000
U1	IC ULN2803A TRANSISTOR ARRAY	56289	ULN2803A	1	534274000
U2-3	IC UDN2585A	56289	UDN2585A	2	534392000
U4	IC 8279-2 KEYBD/DISP INTERFACE	33297	uPD8279C-2	1	534211000
U5-7	IC 74LS138 DECDR/MPX	01295	SN74LS138N	3	534246000
U8-10	IC 74LS273 OCTAL D FLIPFLOP	01295	SN74LS273N	3	534263000
U12	IC 74LS273 OCTAL D FLIPFLOP	01295	SN74LS273N	1	534263000
U14	IC 74LS273 OCTAL D FLIPFLOP	01295	SN74LS273N	1	534263000
U16	IC 74LS273 OCTAL D FLIPFLOP	01295	SN74LS273N	1	534263000
U17-19	IC 74LS138 DECDR/MPX	01295	SN74LS138N	3	534246000
U20	IC 74LS00 2 INP POS NAND	01295	SN74LS00N	1	534167000
XDS1-6	SOCKET IC 14 PIN	06776	ICN-143-WB-G	6	473066000
XDS7-8	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	2	473047000
XDS9-16	SOCKET IC 14 PIN	06776	ICN-143-WB-G	8	473066000
XDS17-19	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	3	473047000
XDS20-21	SOCKET IC 14 PIN	06776	ICN-143-WB-G	2	473066000
XDS22	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000
XR1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XR4-10	SOCKET IC 16 PIN	06776	ICN-163-S3-G	7	473042000
XU1-3	SOCKET IC 18 PIN	06776	ICN-183-S3-TG	3	473045000
XU4	SOCKET IC 40 PIN LOW PROFILE	06776	ICT-406-S-TG	1	473068000
XU5-7	SOCKET IC 16 PIN	06776	ICN-163-S3-G	3	473042000
XU8-10	SOCKET IC 20 PIN	06776	ICN-203-S3-G	3	473065000
XU12	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU14	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU16	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU17-19	SOCKET IC 16 PIN	06776	ICN-163-S3-G	3	473042000
XU20	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000

11201502A PWA 1130 MOTHER
MODEL: 1130

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C2	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
J23-24	HEADER 5 PIN STRAIGHT	06383	MPSS156-5-D	2	477345000
J26	CONNECTOR "SMB"	19505	209	1	477317000
J28	CONNECTOR "SMB"	19505	209	1	477317000
U1	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
U2	IC 74LS541 OCTAL BUFFER	01295	SN74LS541N	1	534381000
U3	IC 78L05 VOLT REG	07263	uA78L05AWC	1	535044000
XU1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU2	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000

SECTION VII
SCHEMATIC DIAGRAMS

TABLE 7-1. LIST OF SCHEMATICS.

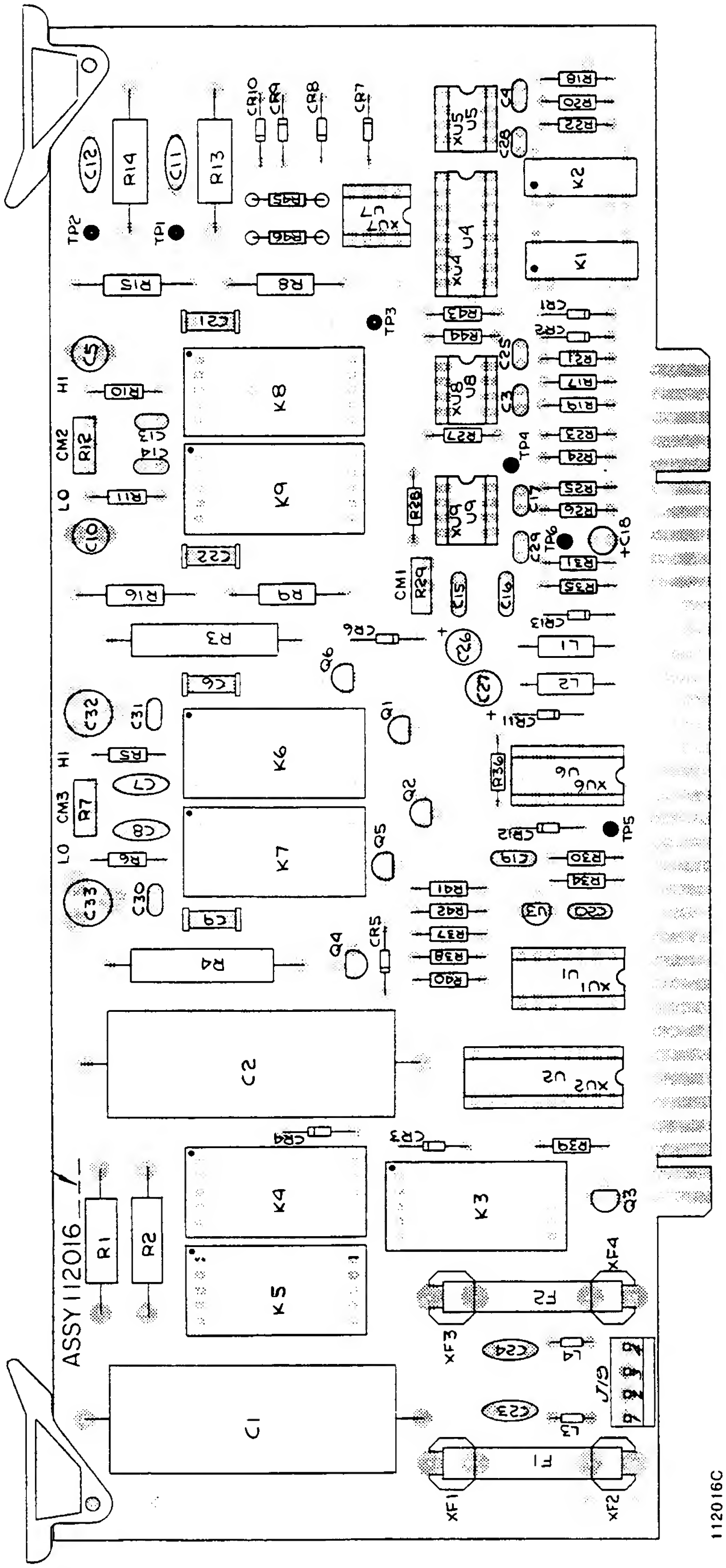
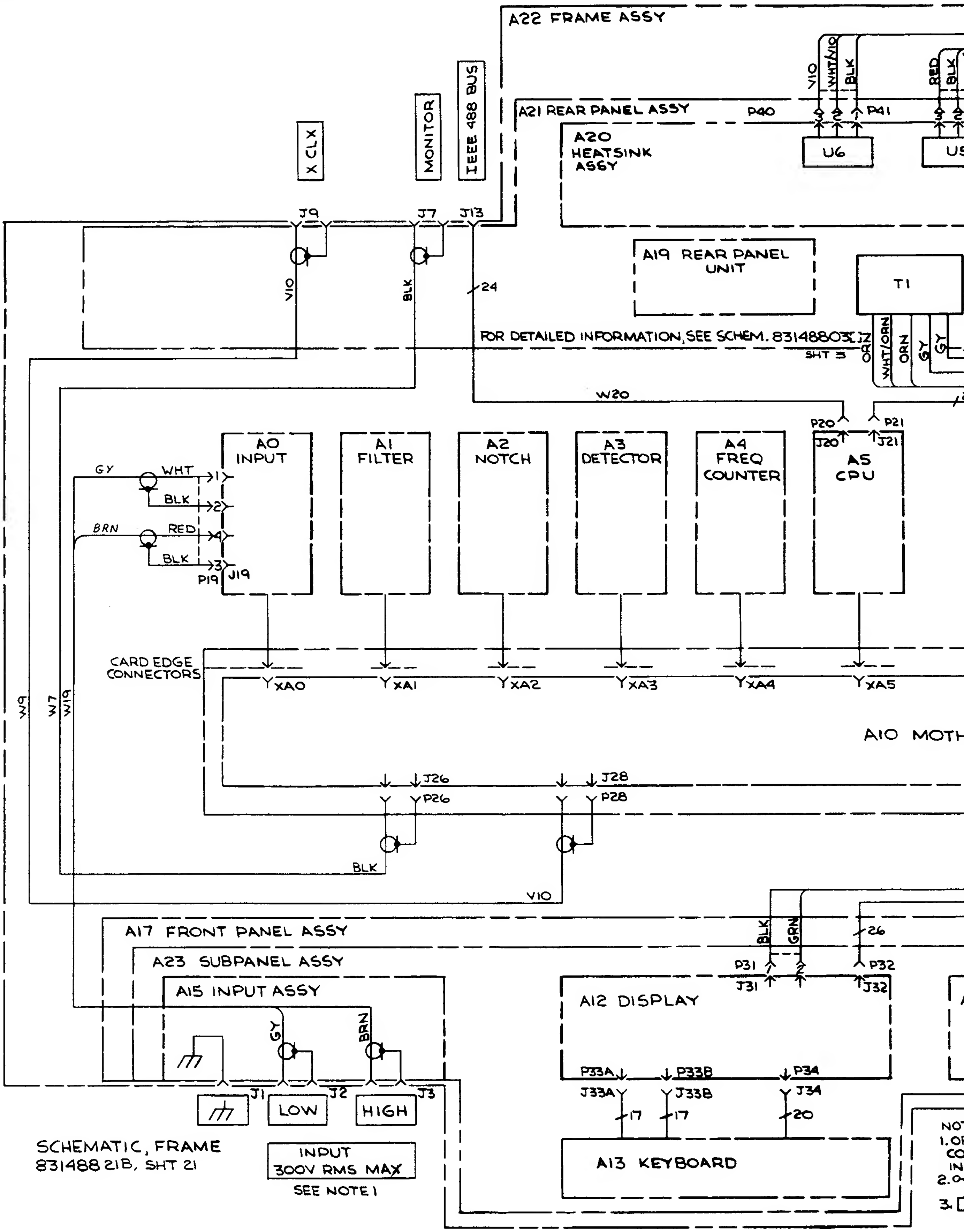


Figure 7-2. Input Board A0 Parts Location Diagram.



SCHEMATIC, FRAME
83148821B, SHT 21

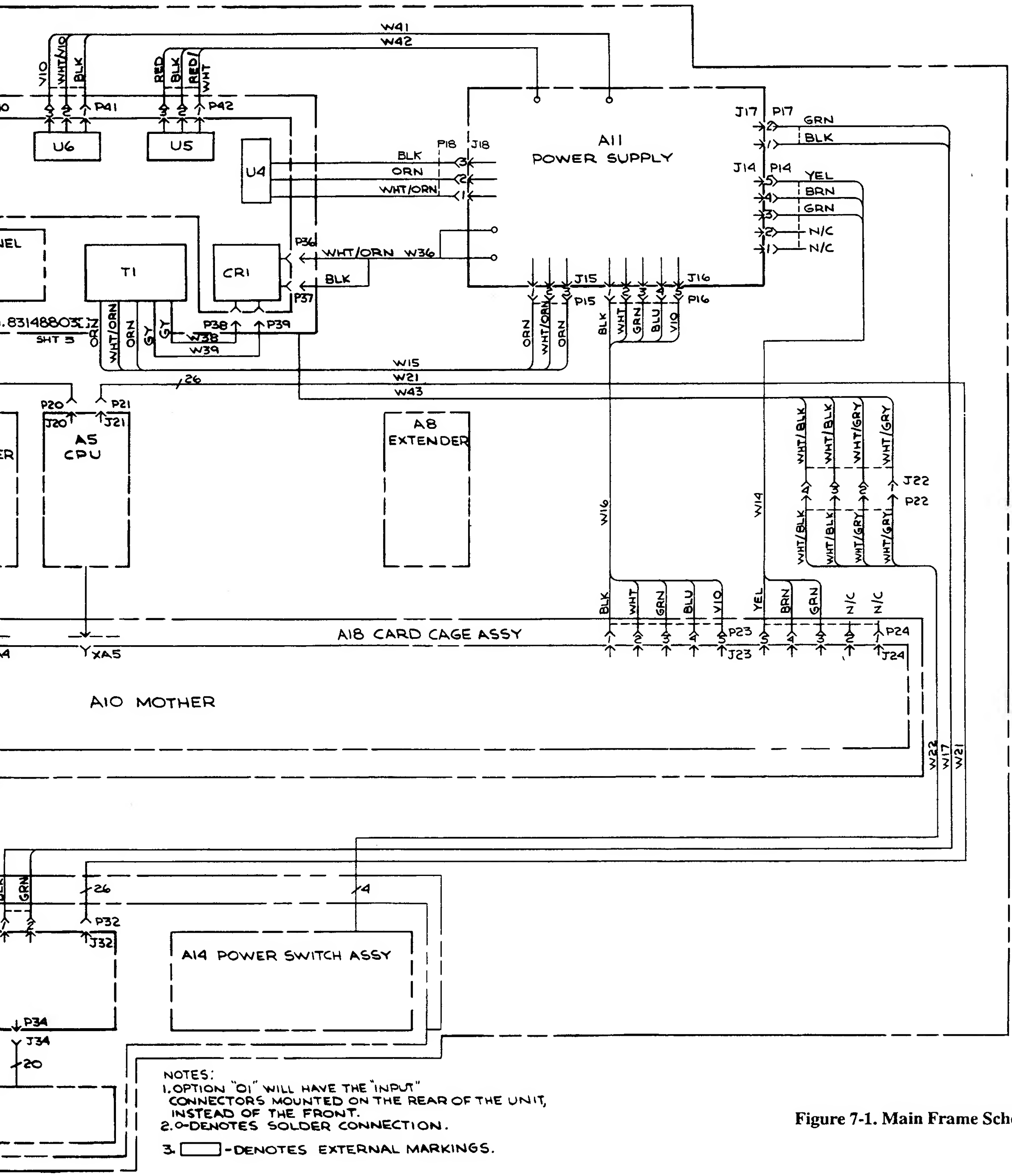


Figure 7-1. Main Frame Schematic.

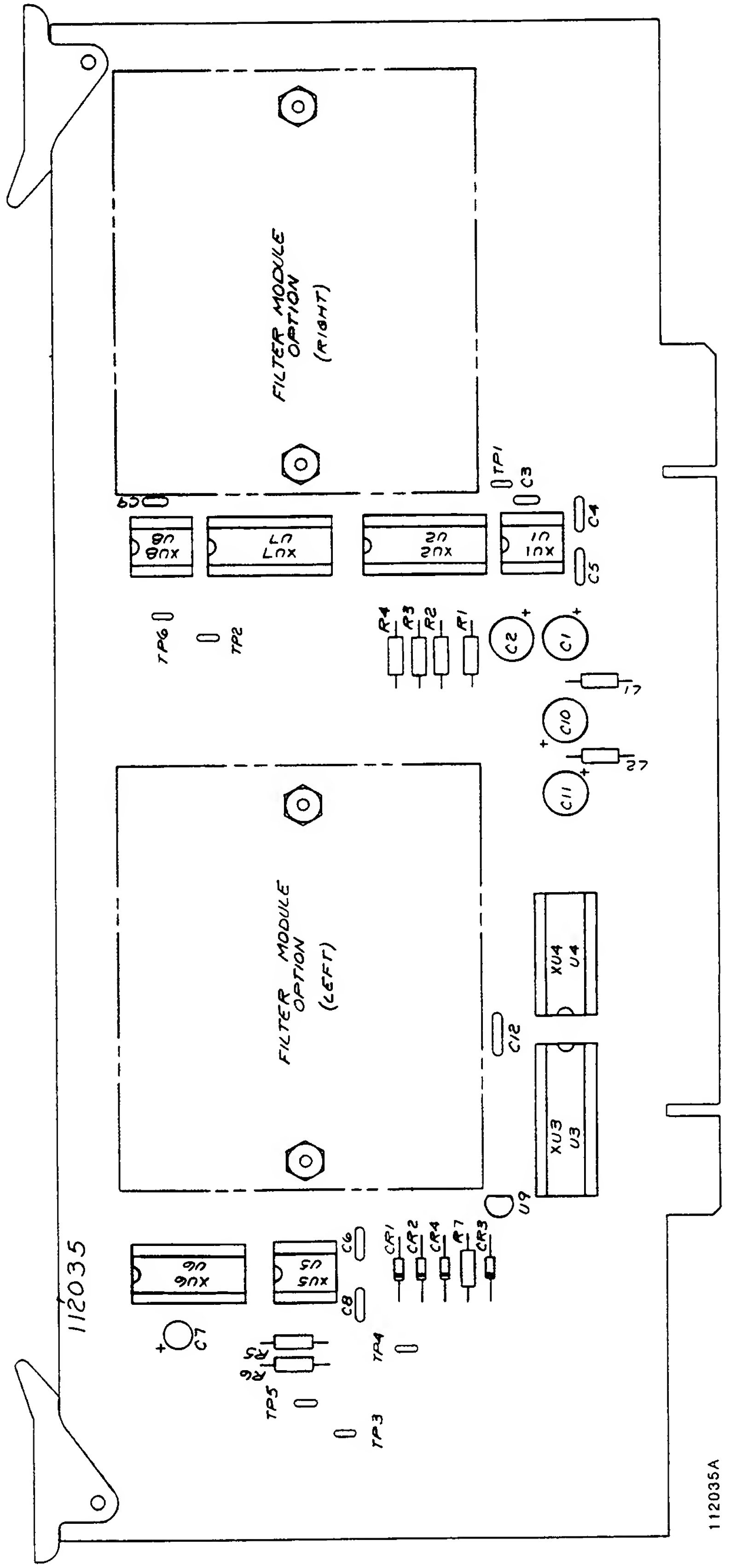
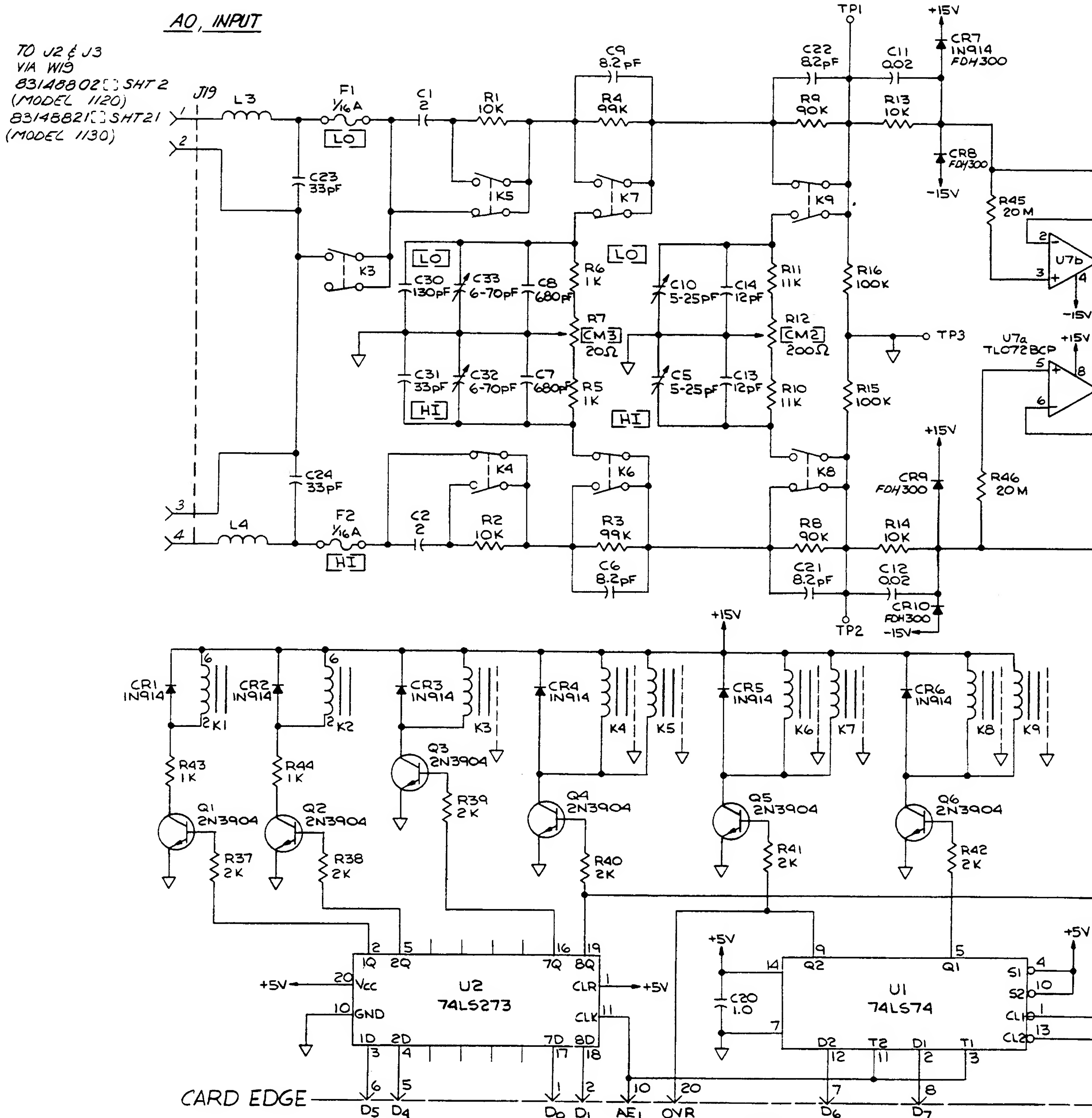
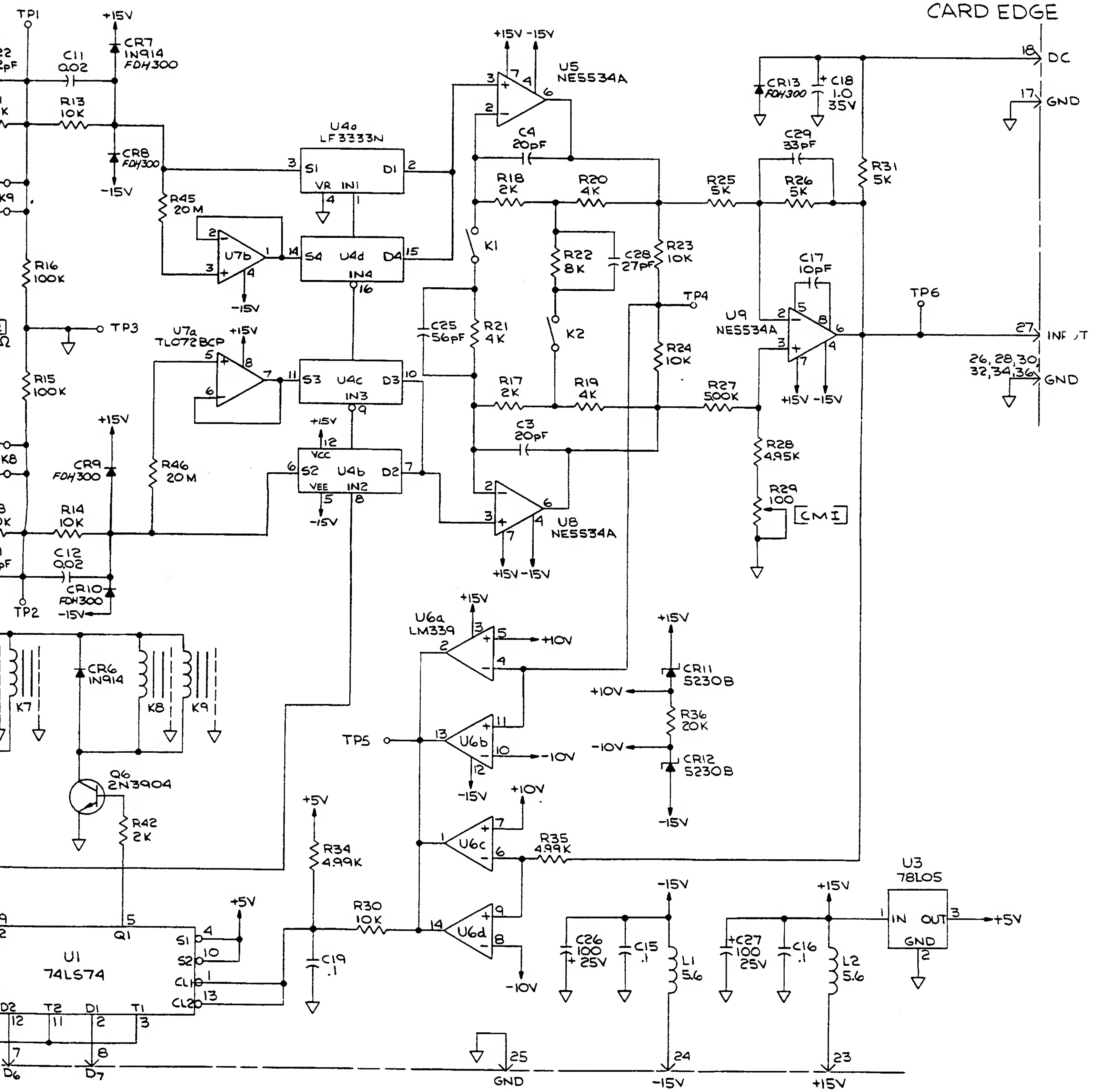


Figure 7-4. Filter Board A1 Parts Location Diagram.



SCHEMATIC, INPUT
83148808E, SHT 8

NOTES:
1. CAPACITANCE VALUES IN µF UNLESS OT
2. RESISTANCE VALUES IN OHMS UNLES
3. LAST NUMBERS USED:
C33, R46, U9



TANCE VALUES IN µF UNLESS OTHERWISE SPECIFIED.
TANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
NUMBERS USED:
46, U9

Figure 7-3. Input Board A0 Schematic

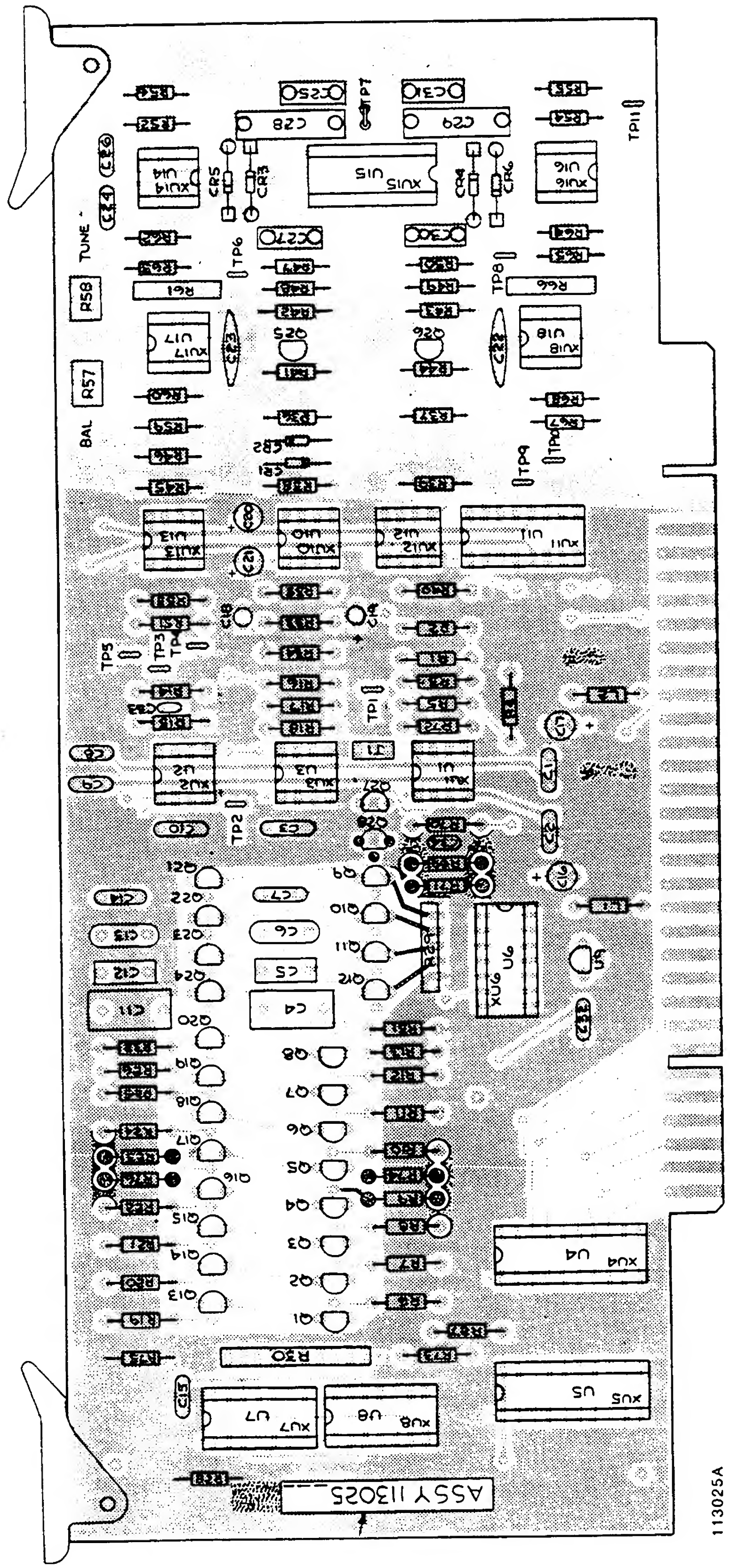
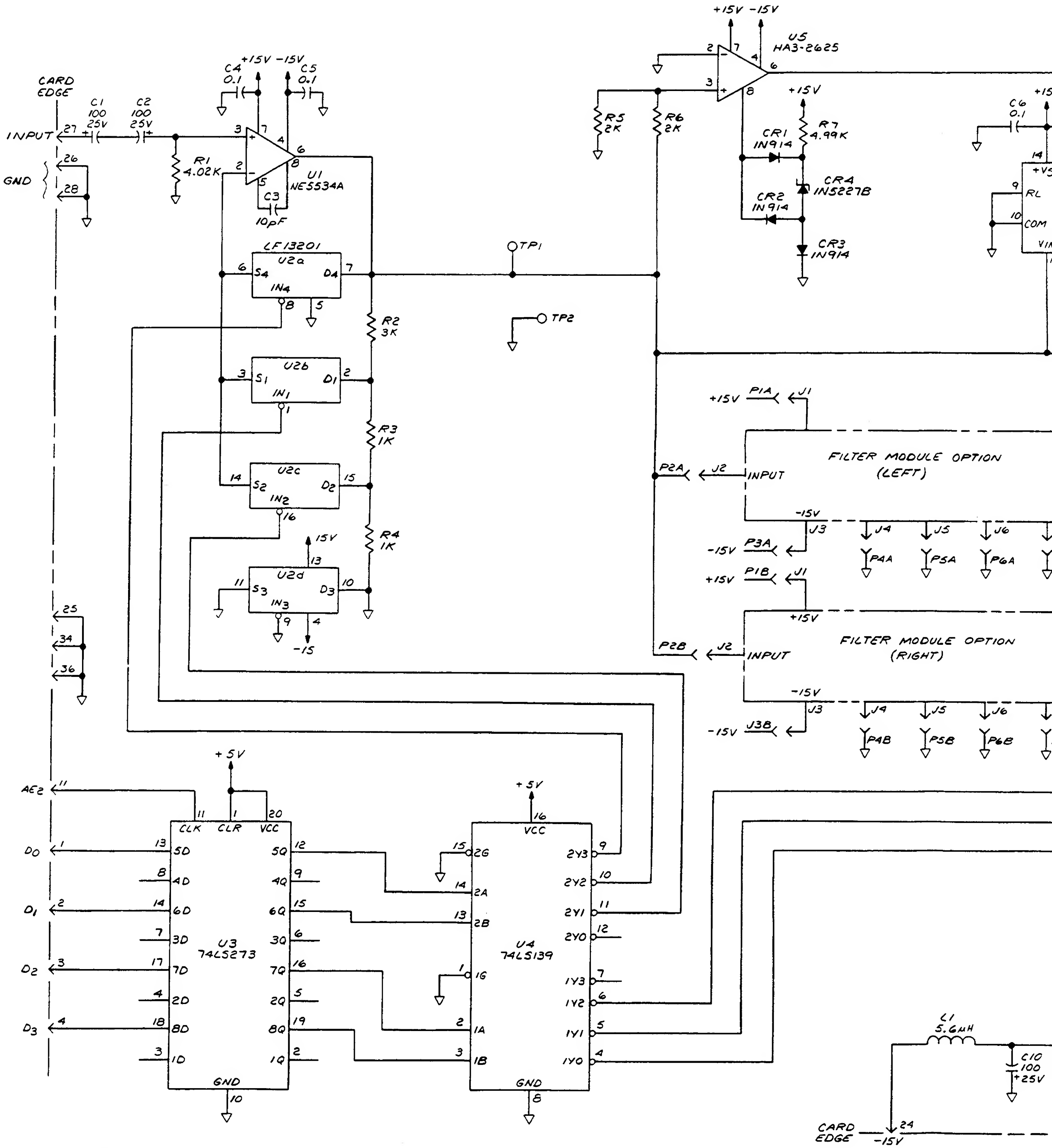


Figure 7-6. Notch Board A2 Parts Location Diagram.



SCHEMATIC : FILTER
83148824B, SHT 24

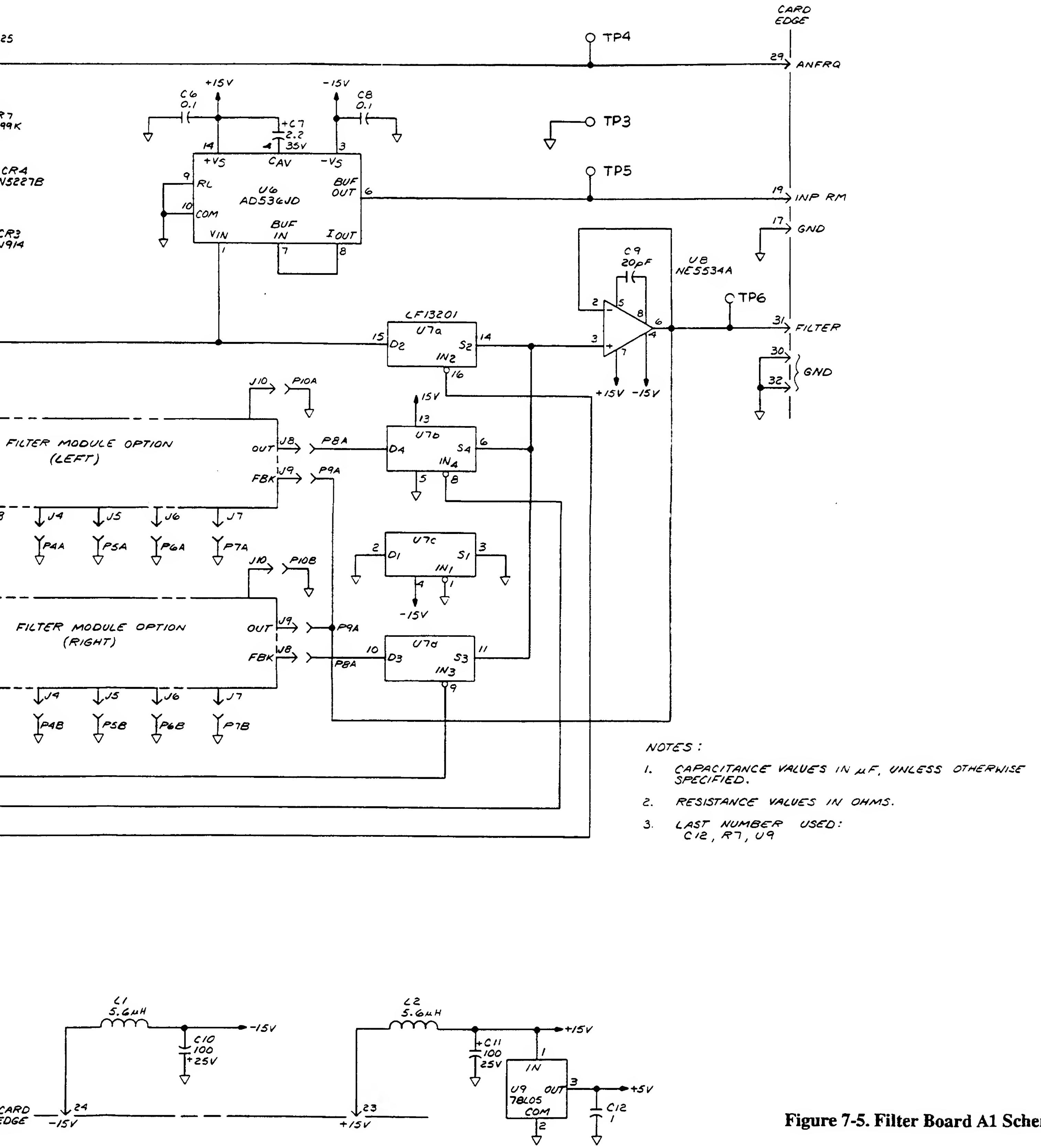
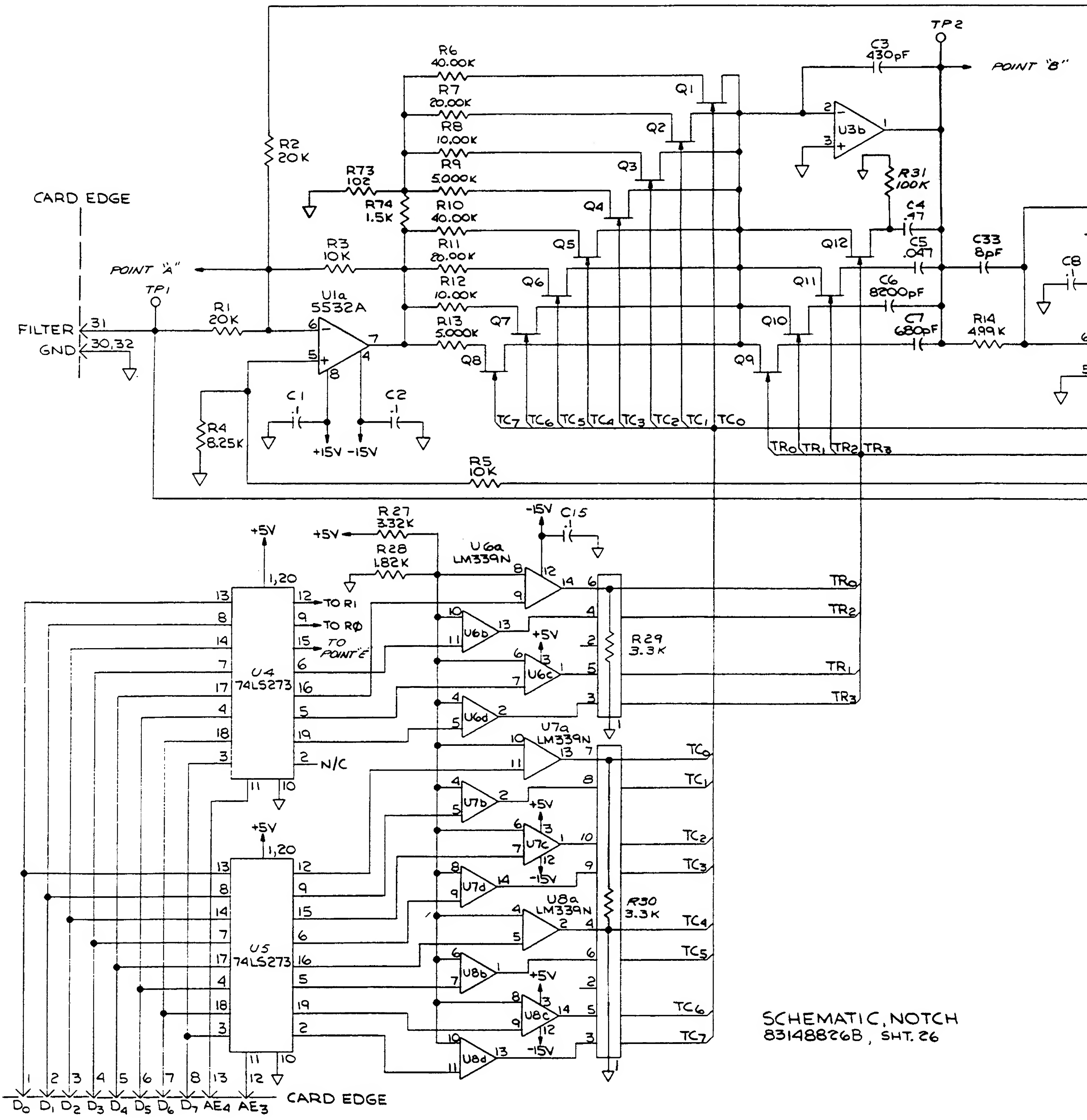
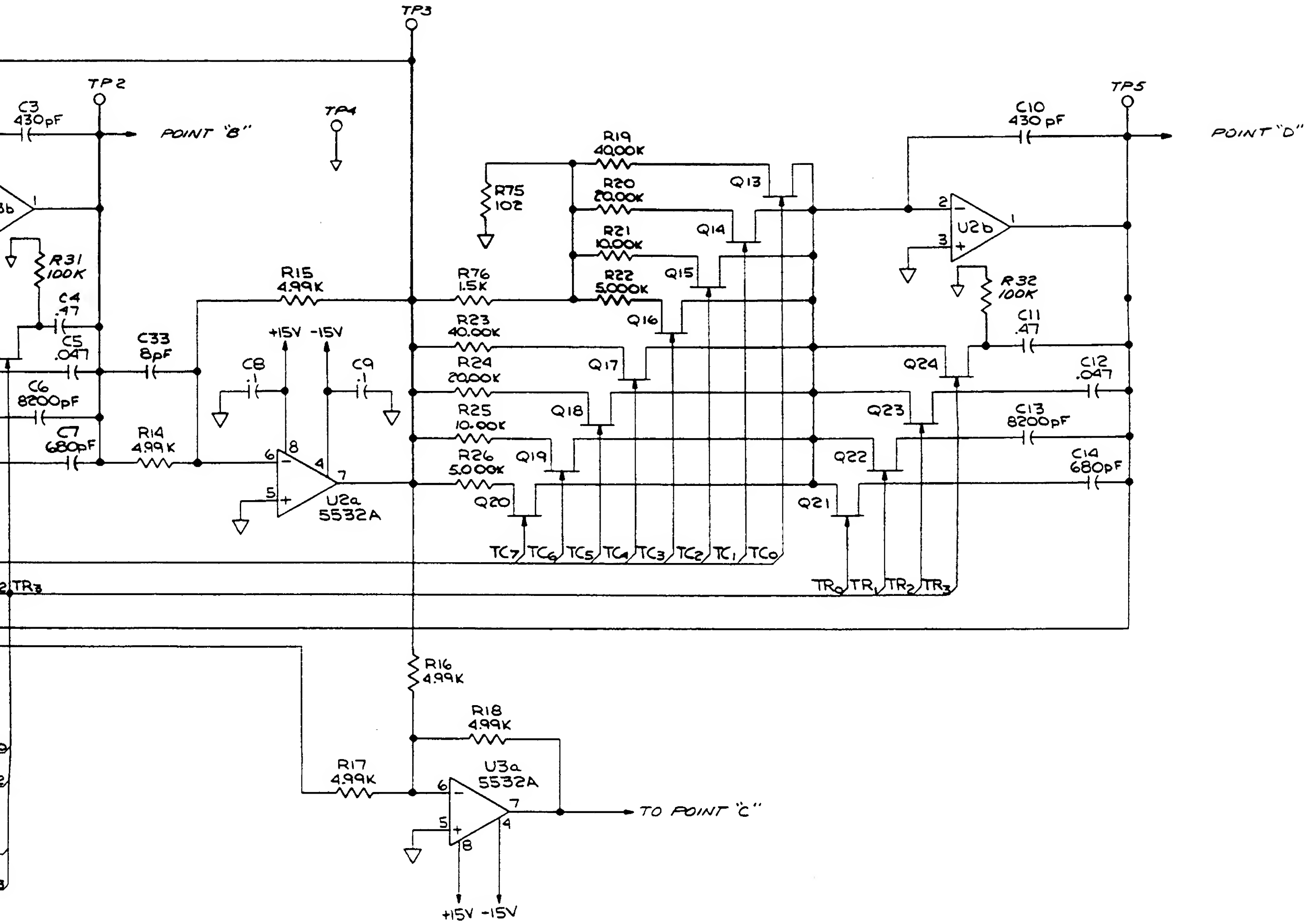


Figure 7-5. Filter Board A1 Schematic.


CARD EDGE
FILTER
GND
POINT "A"
POINT "B"
TP1
TP2
U1a 5532A
U3b
U4 74LS273
U5 74LS273
U6a LM339N
U7a LM339N
U8a LM339N
R29 3.3K
R30 3.3K
TO R1
TO RØ
TO POINT "E"
N/C
D0 D1 D2 D3 D4 D5 D6 D7 AE4 AE3
CARD EDGE
SCHEMATIC, NOTCH
83148826B, SHT. 26



NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. ALL DIODES TO BE TYPE 1N914, UNLESS OTHERWISE SPECIFIED.
4. ALL TRANSISTORS TO BE TYPE J108, UNLESS OTHERWISE SPECIFIED.
5. LAST NUMBER USED: C33, Q31, R76, TP11, U18

Figure 7-7. Notch Board A2 Schematic Shee

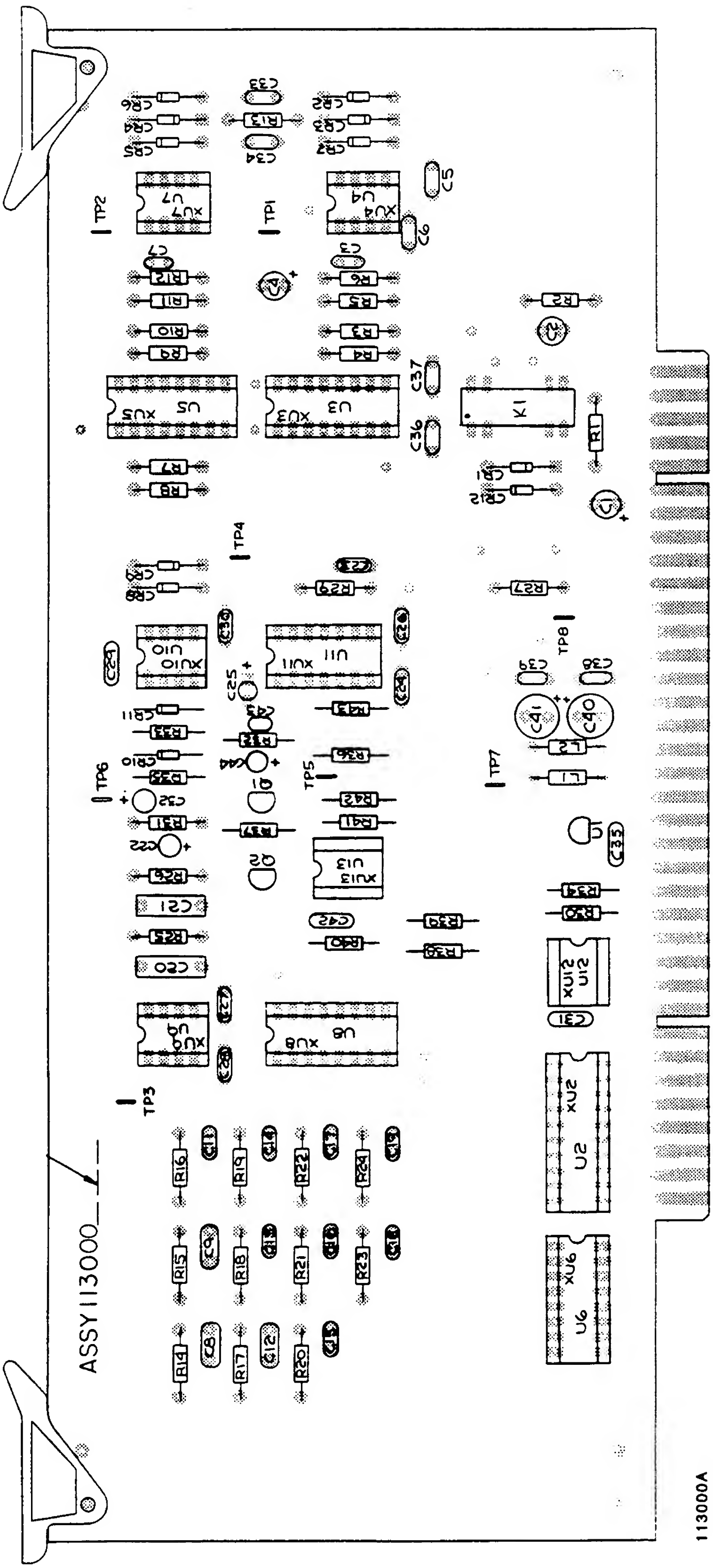
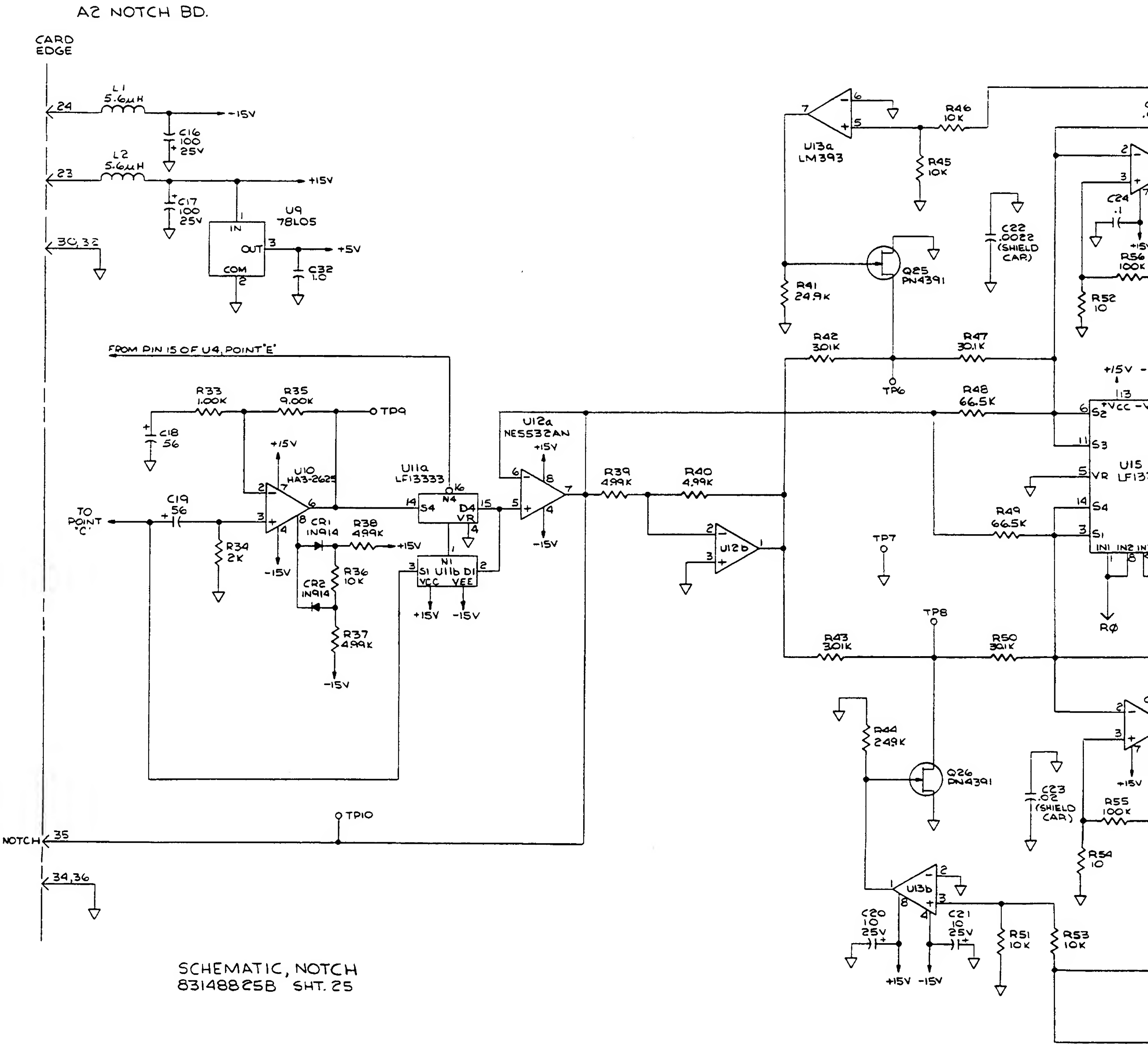


Figure 7-9. Detector Board A3 Parts Location Diagram.



SCHEMATIC, NOTCH
83148825B SHT. 25

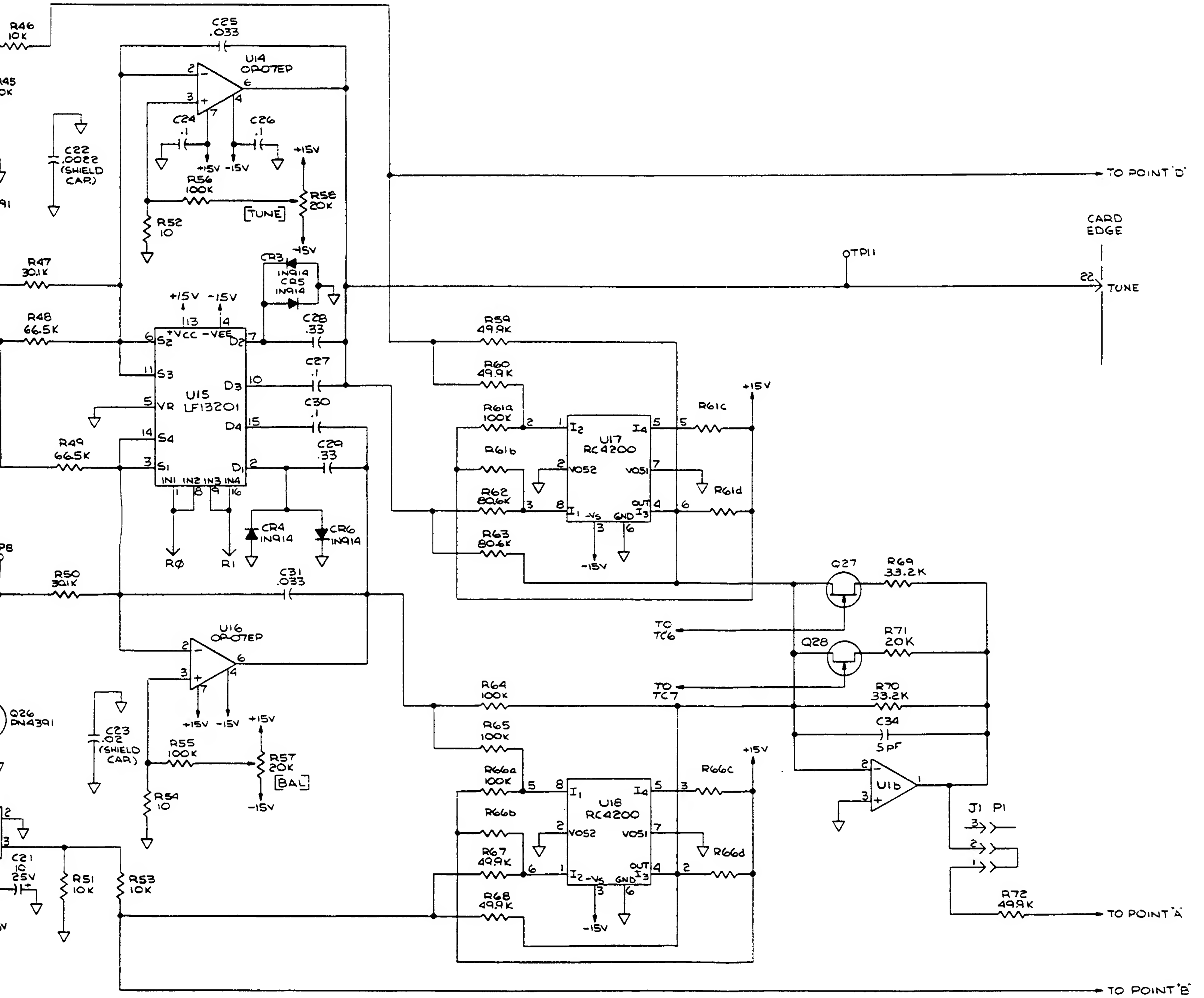


Figure 7-8. Notch Board A2 Schematic Sheet

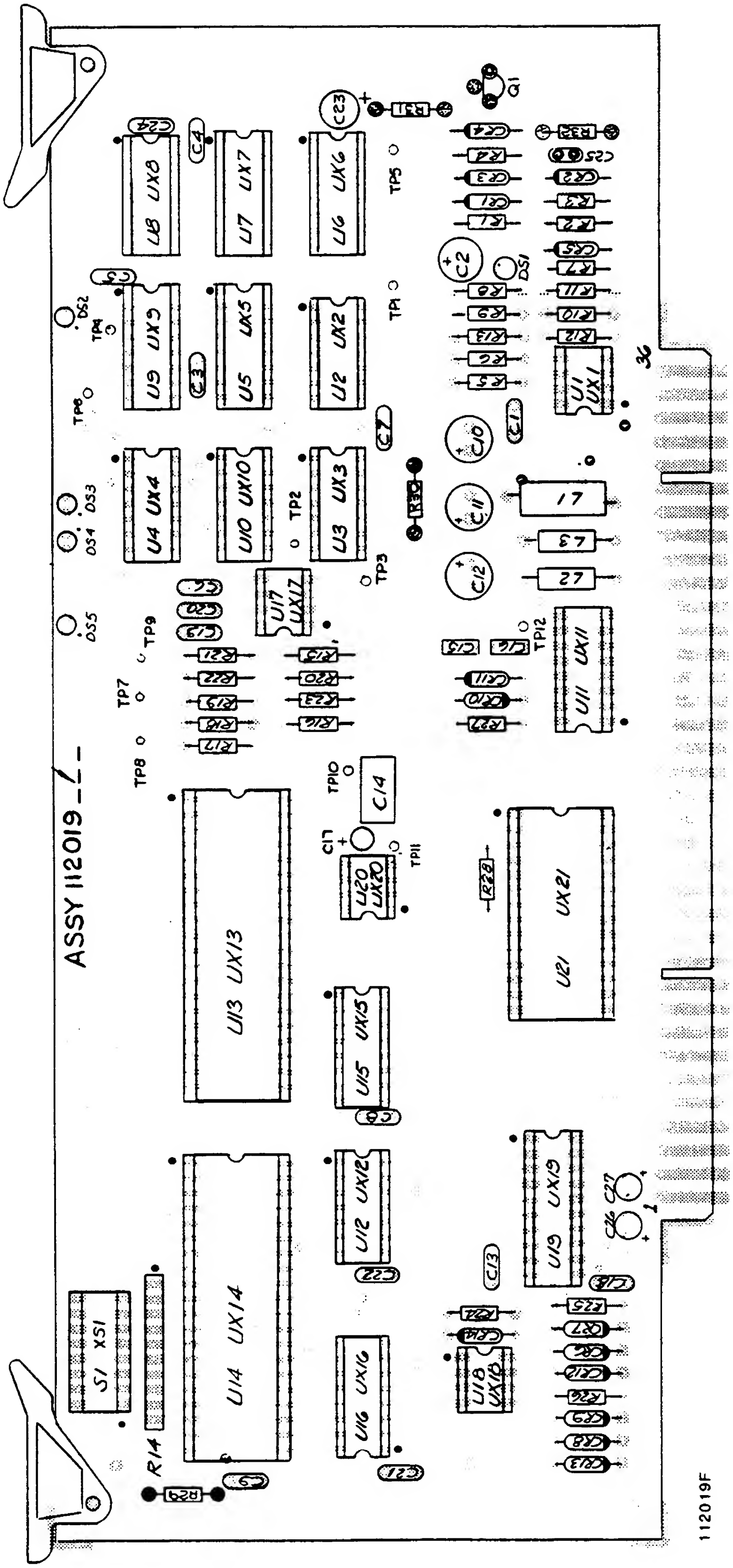
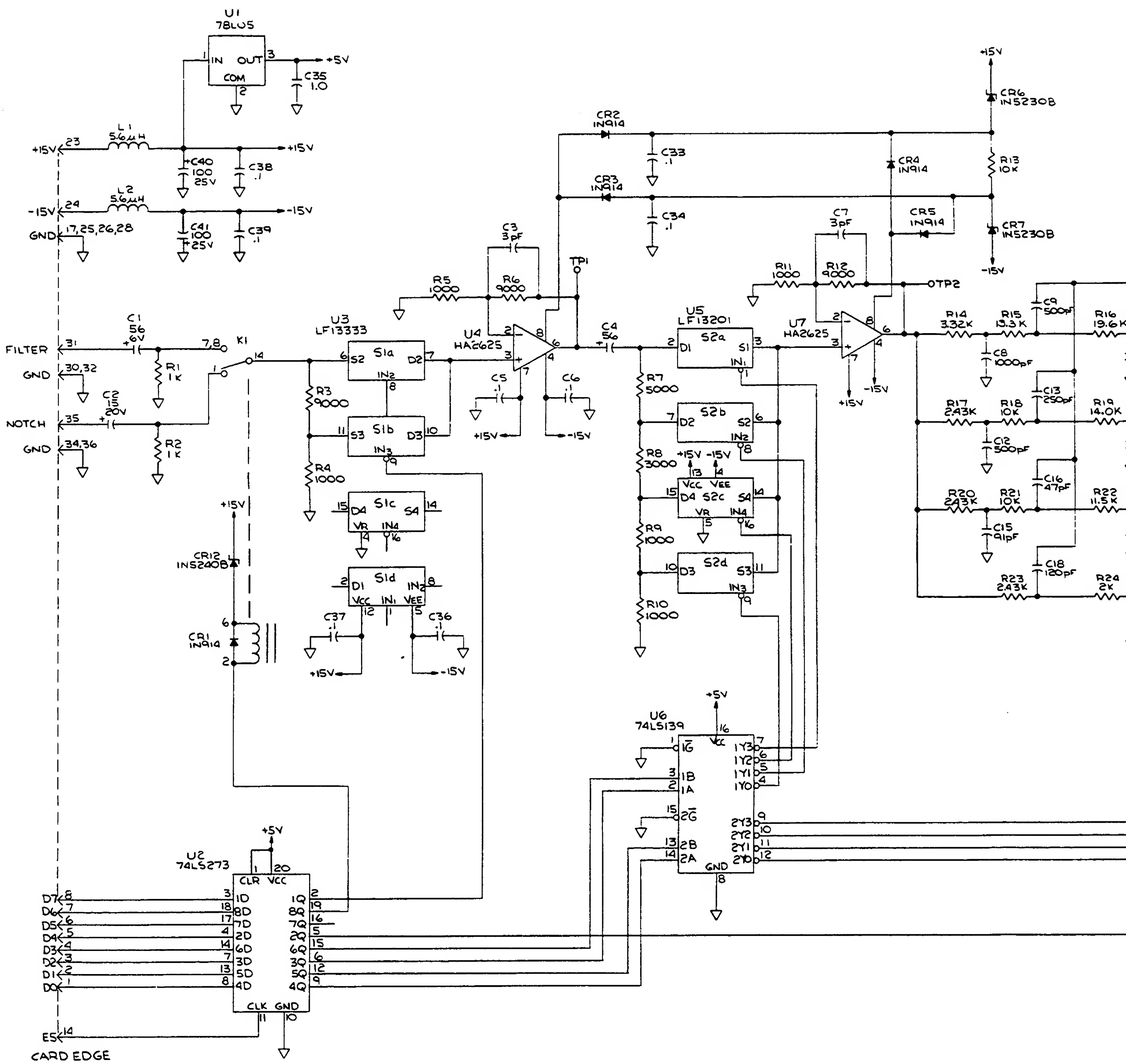


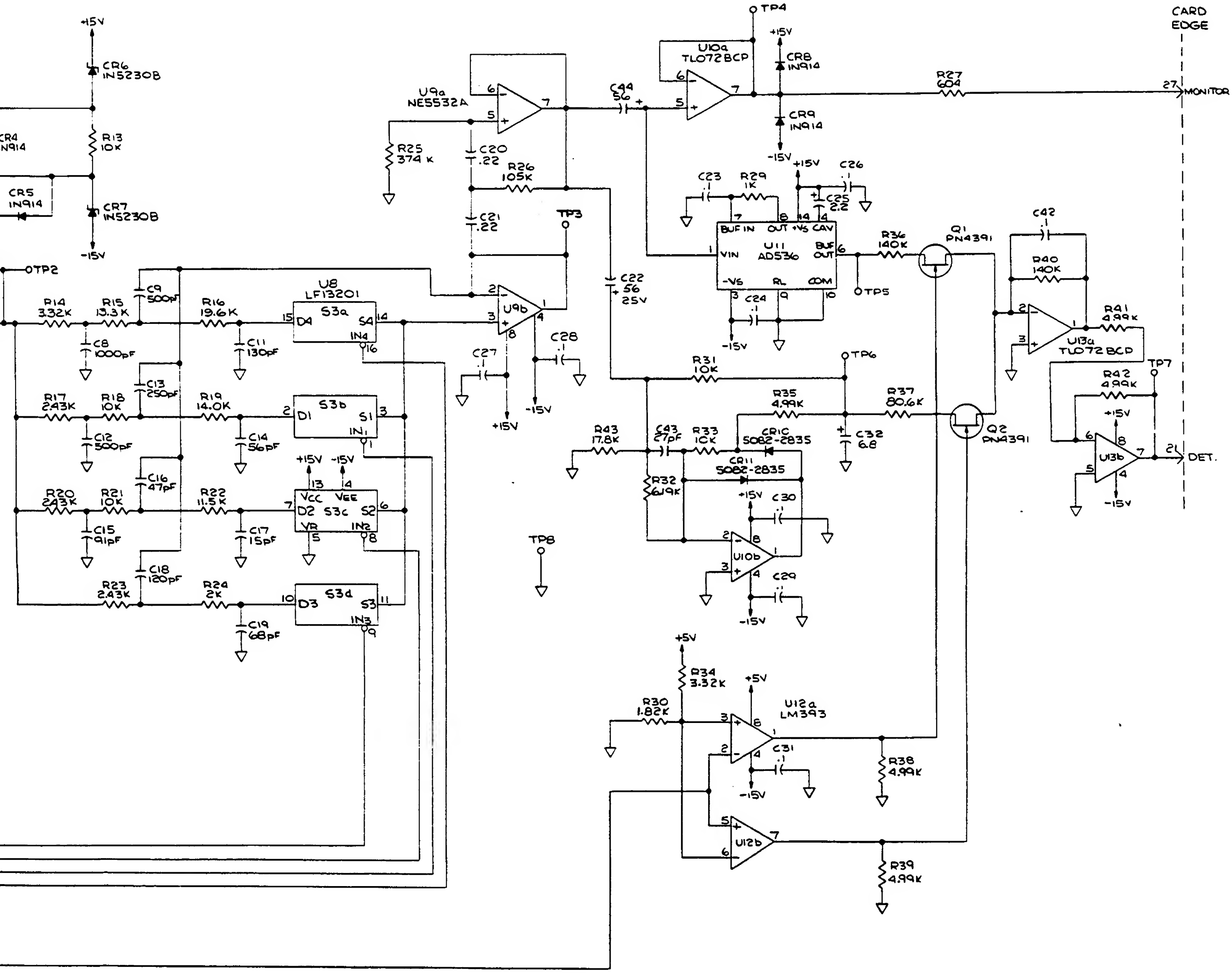
Figure 7-11. Counter Board A4 Parts Location Diagram.

A3 DETECTOR BD.



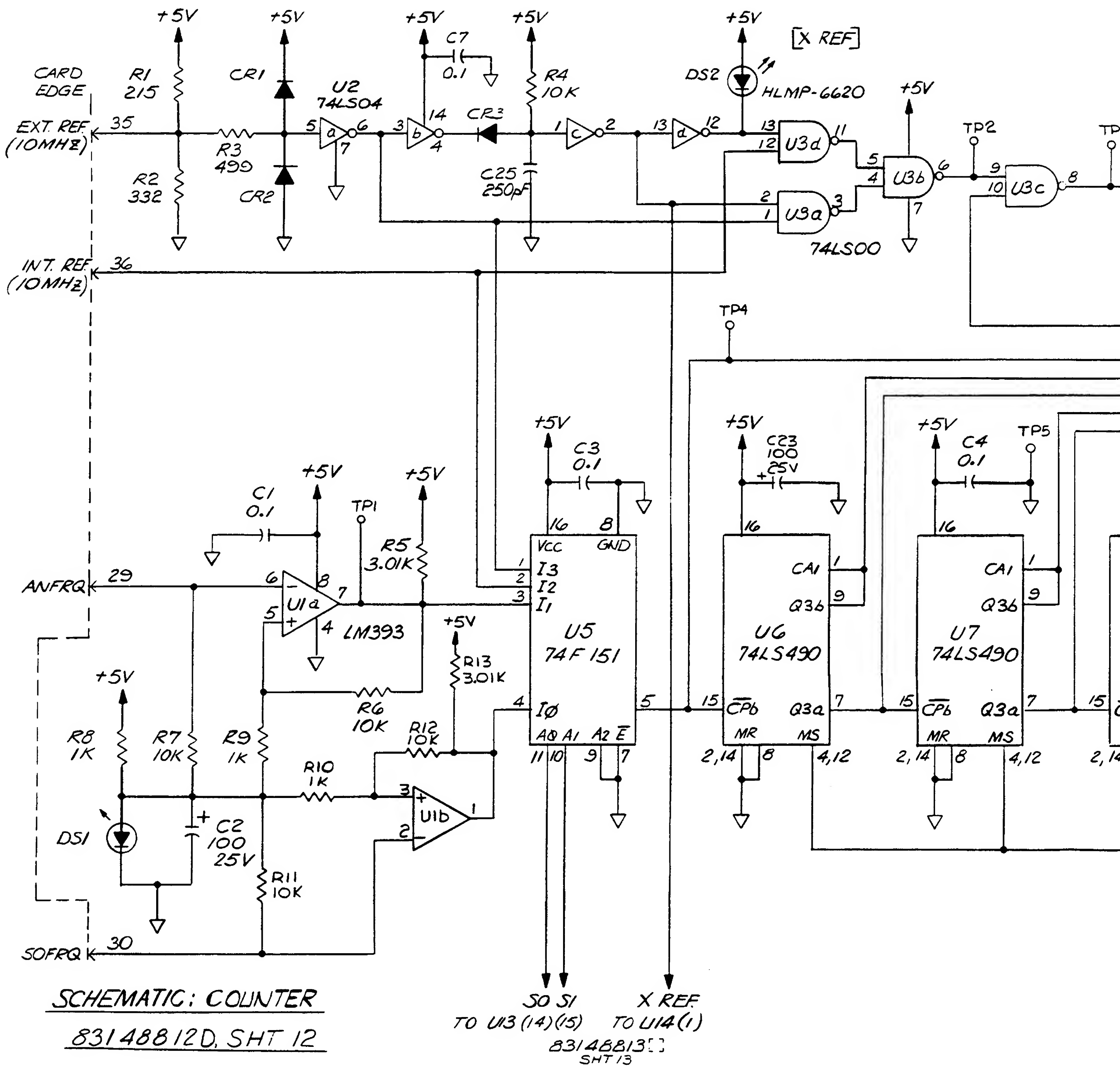
SCHEMATIC, DETECTOR
83148827B SHT. 27

NOTES:
1. CAPACITANCE VALUES IN µF UNLESS OTHERWIS
2. RESISTANCE VALUES IN OHMS UNLESS OTHER
3. LAST NUMBERS USED:
R43, U13, C44, CR12



ALUES IN µF UNLESS OTHERWISE SPECIFIED.
ALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
USED:
, CR12

A4 SCHEMATIC, COUNTER



SCHEMATIC: COUNTER

83148812D, SHT 12

NOTES:

1 - CAPACITANCE VALUES IN µF, UNLESS OTHERWISE SPECIFIED.

2 - RESISTANCE VALUES IN OHMS.

3 - UNLESS OTHERWISE SPECIFIED DIODES ARE 1N914.

4 - LAST NUMBERS USED: R32, C27, L3, U21, CR14, DS5

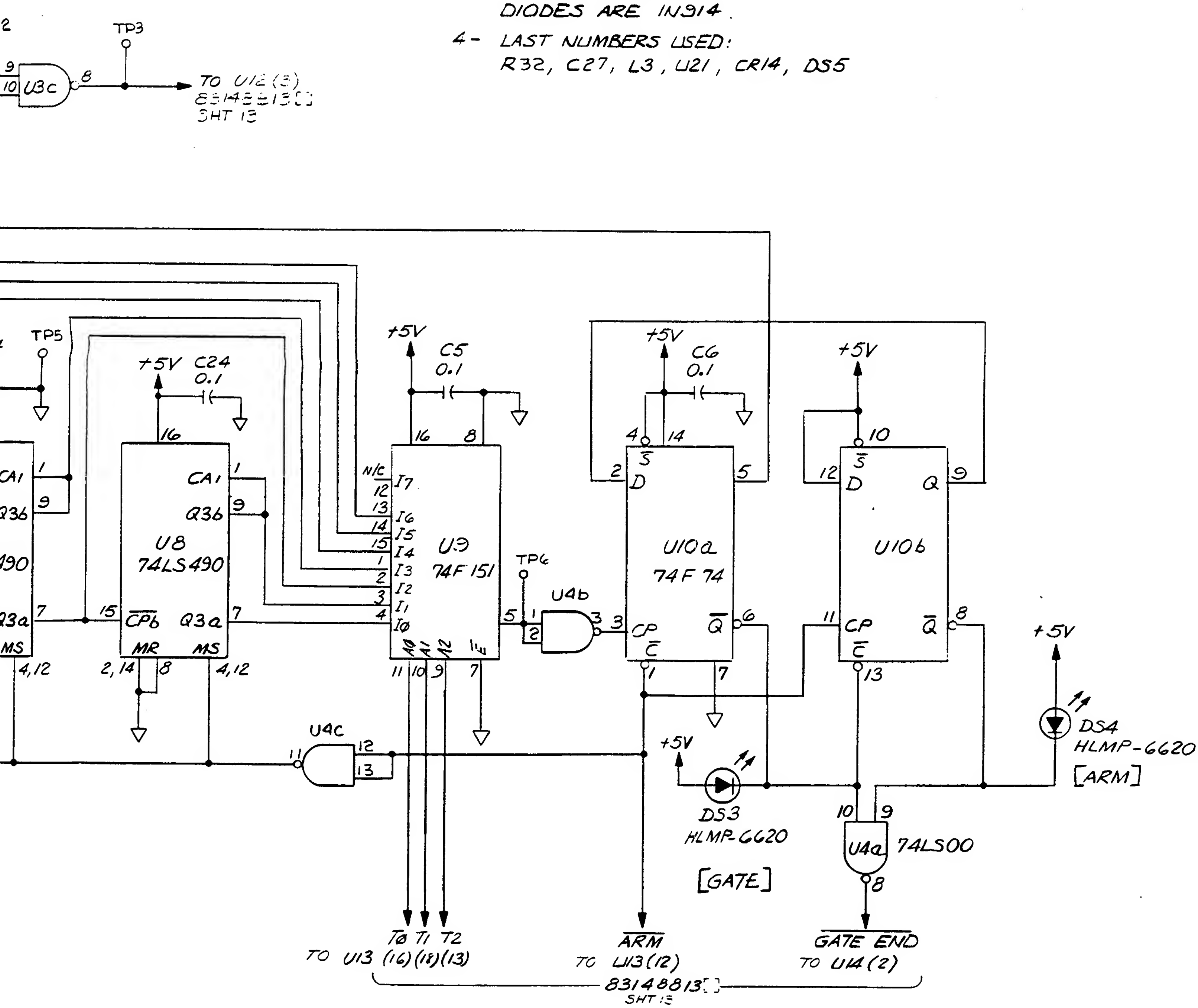
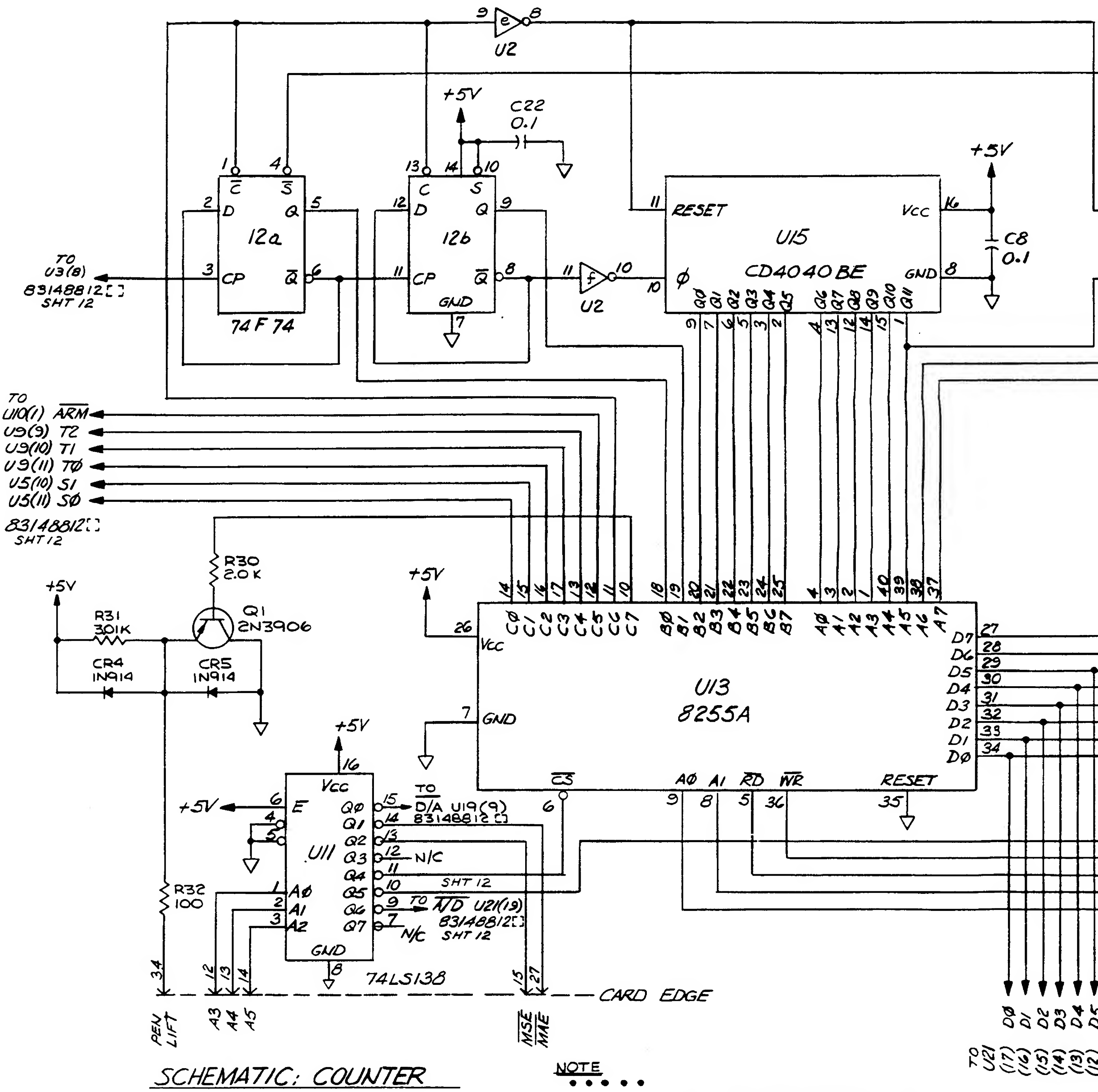


Figure 7-12. Counter Board A4 Schematic Sheet 1.

P/O A4 SCHEMATIC, COUNTER



SCHEMATIC: COUNTER

83148813D, SHT 13

NOTE

1. NOT USED ON MODEL 1110.

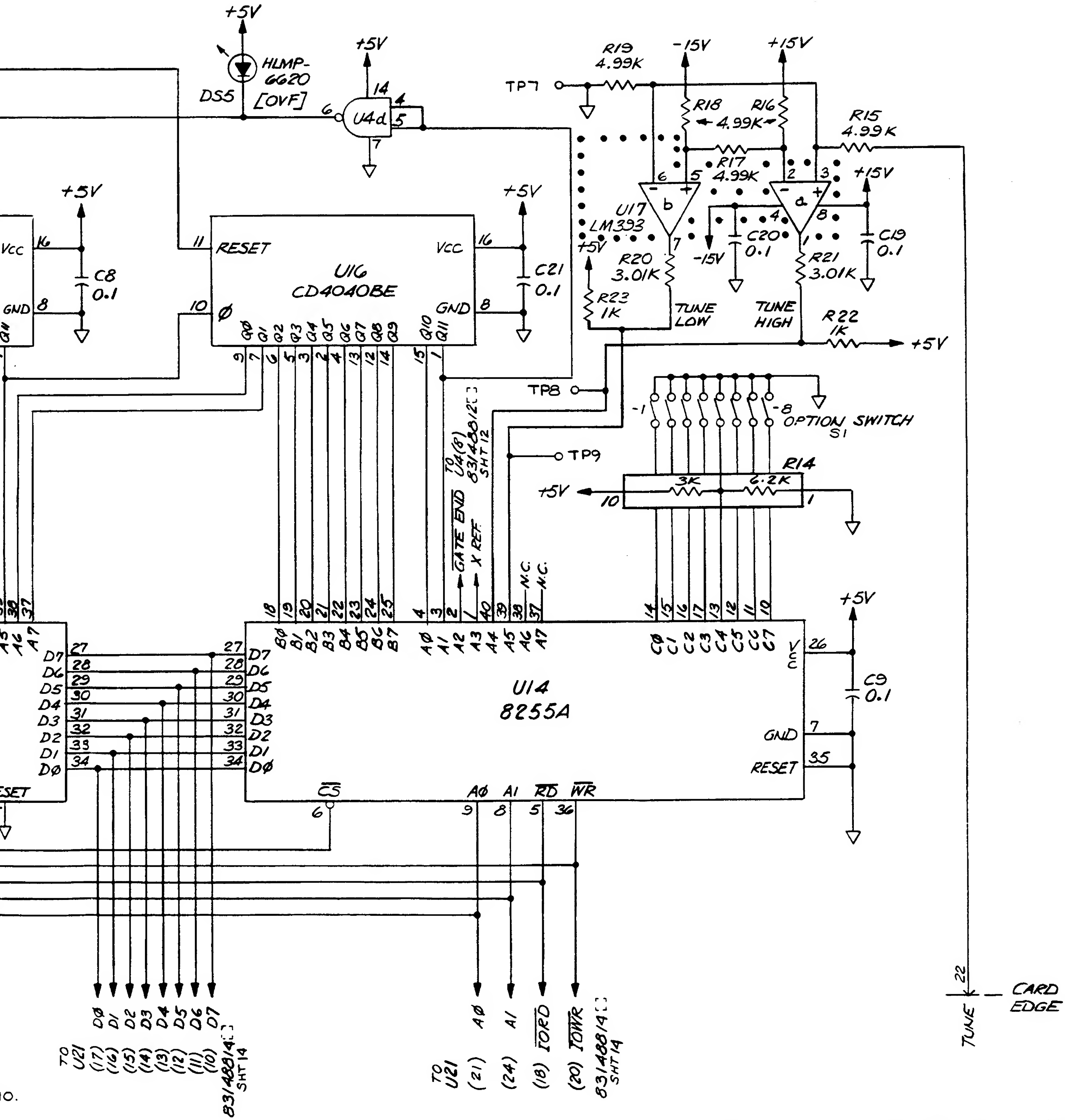
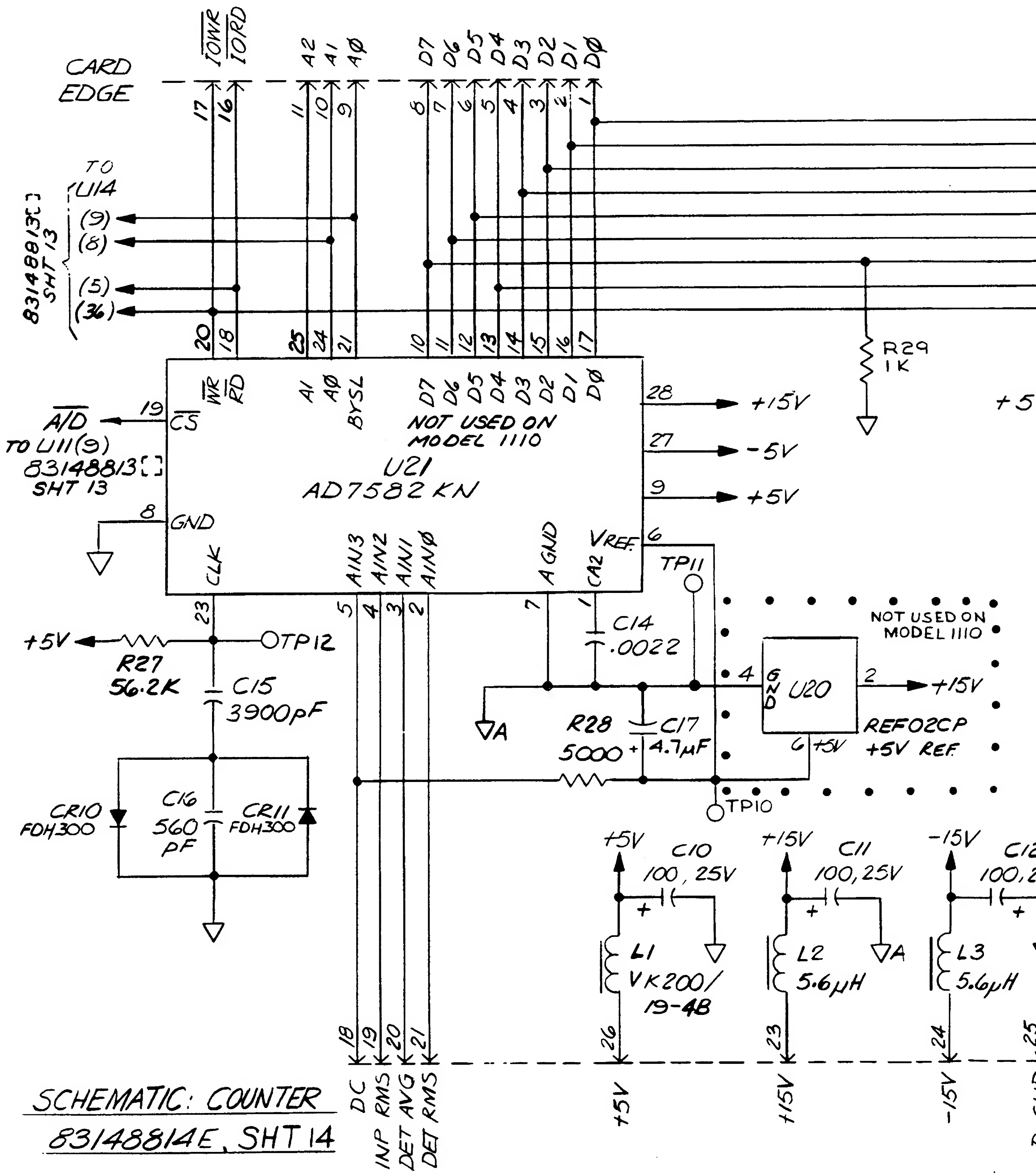


Figure 7-13. Counter Board A4 Schematic Sheet 2

P/O A4 SCHEMATIC, COUNTER



SCHEMATIC: COUNTER

83148814E, SHT 14

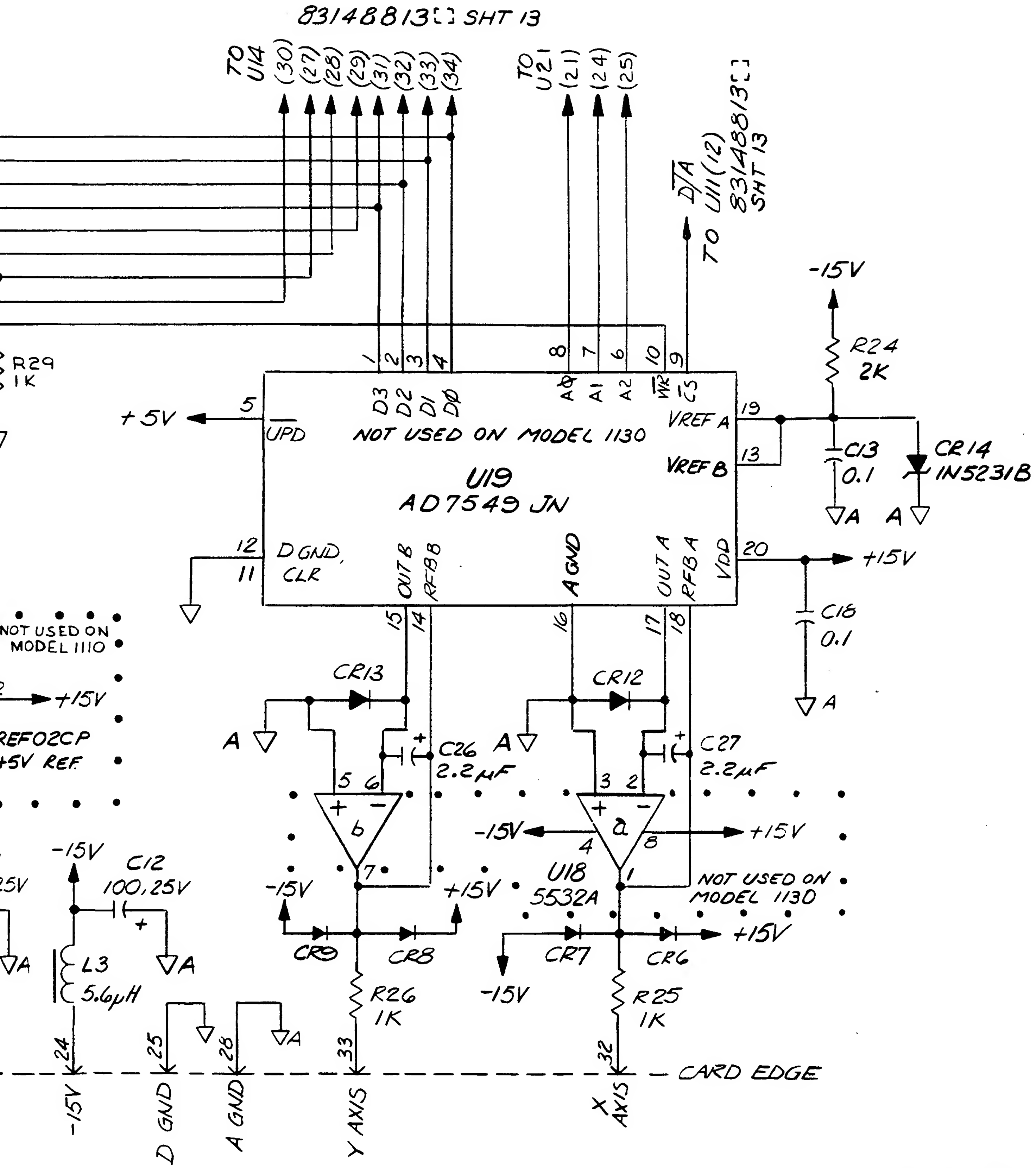


Figure 7-14. Counter Board A4 Schematic Sheet 3.

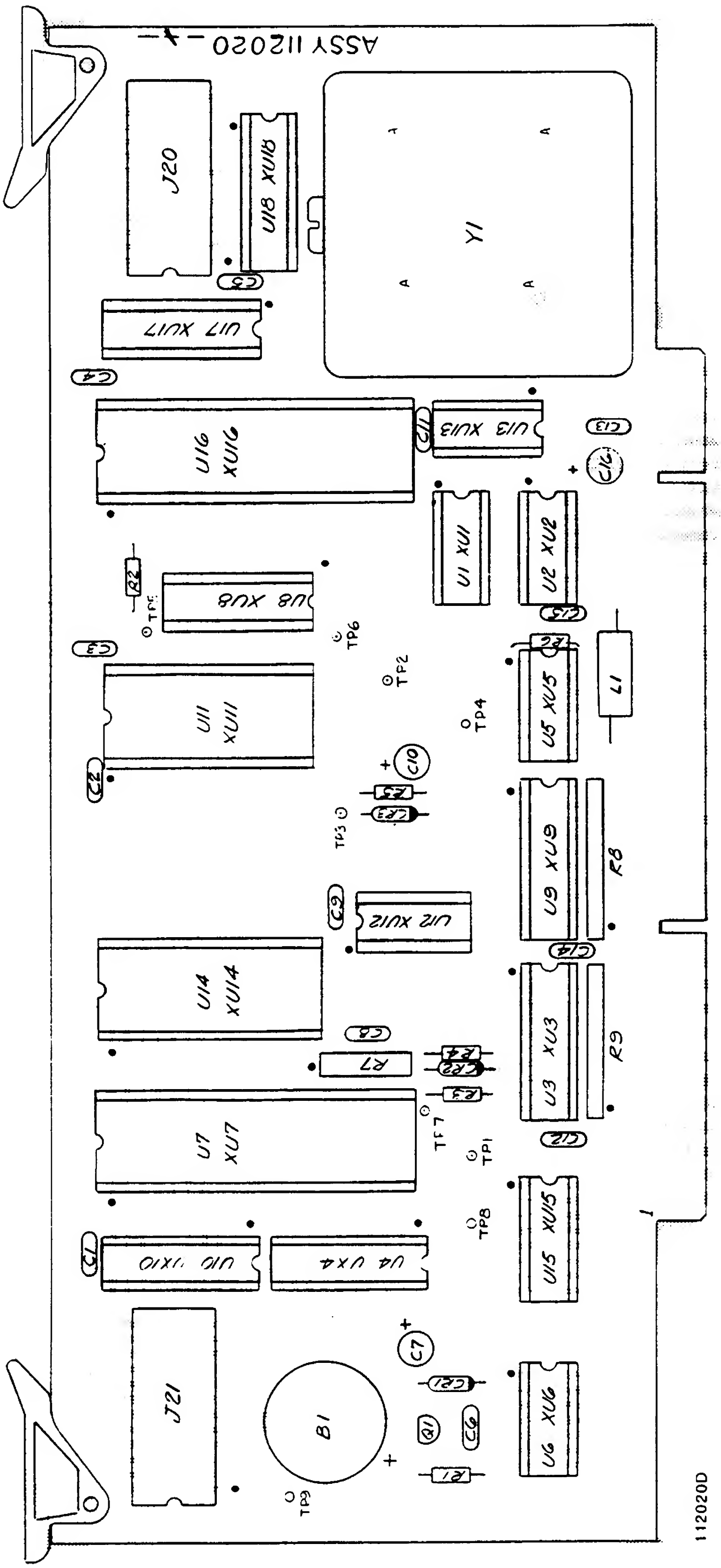


Figure 7-15. C.P.U. Board A5 Parts Location Diagram.

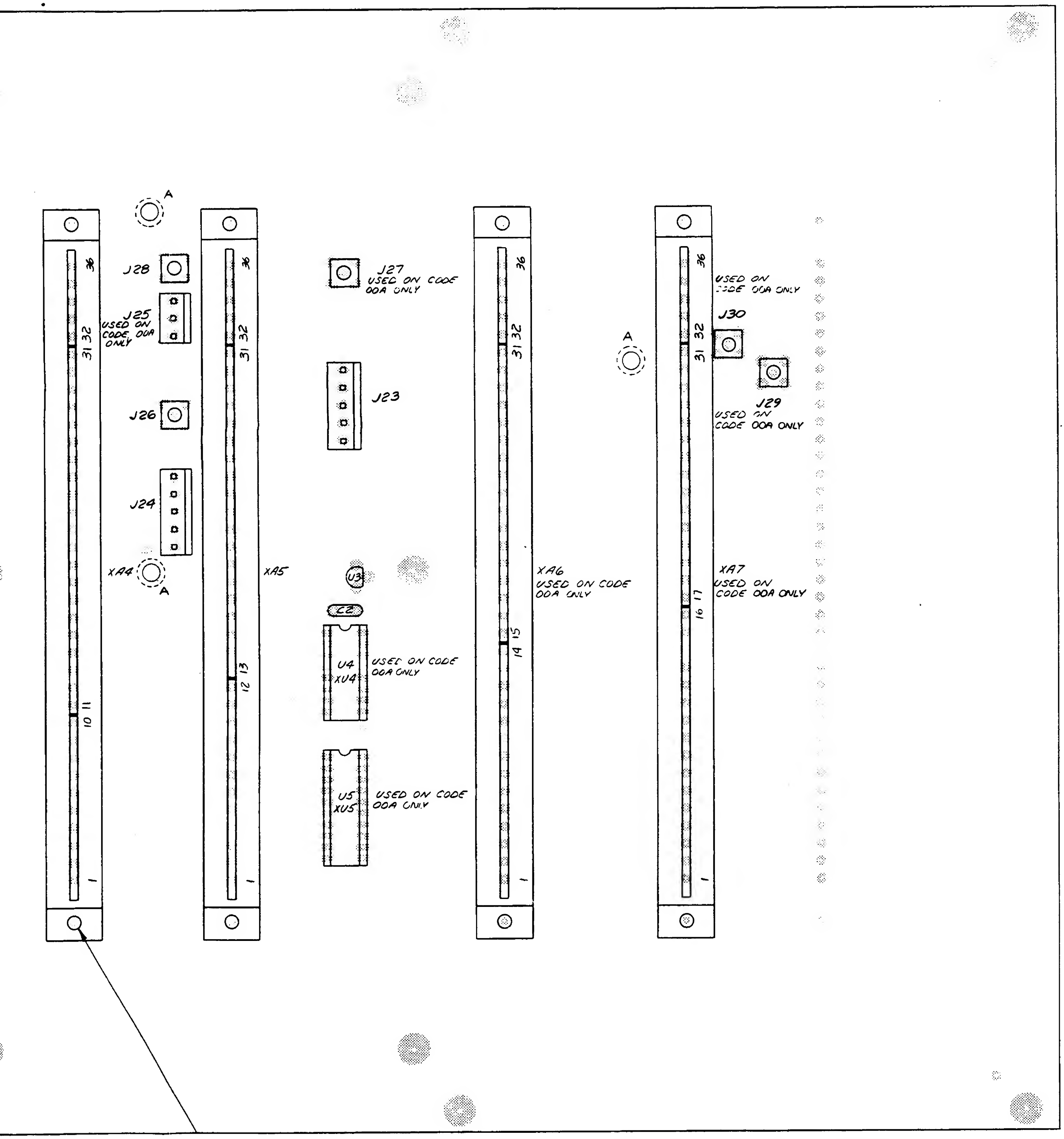
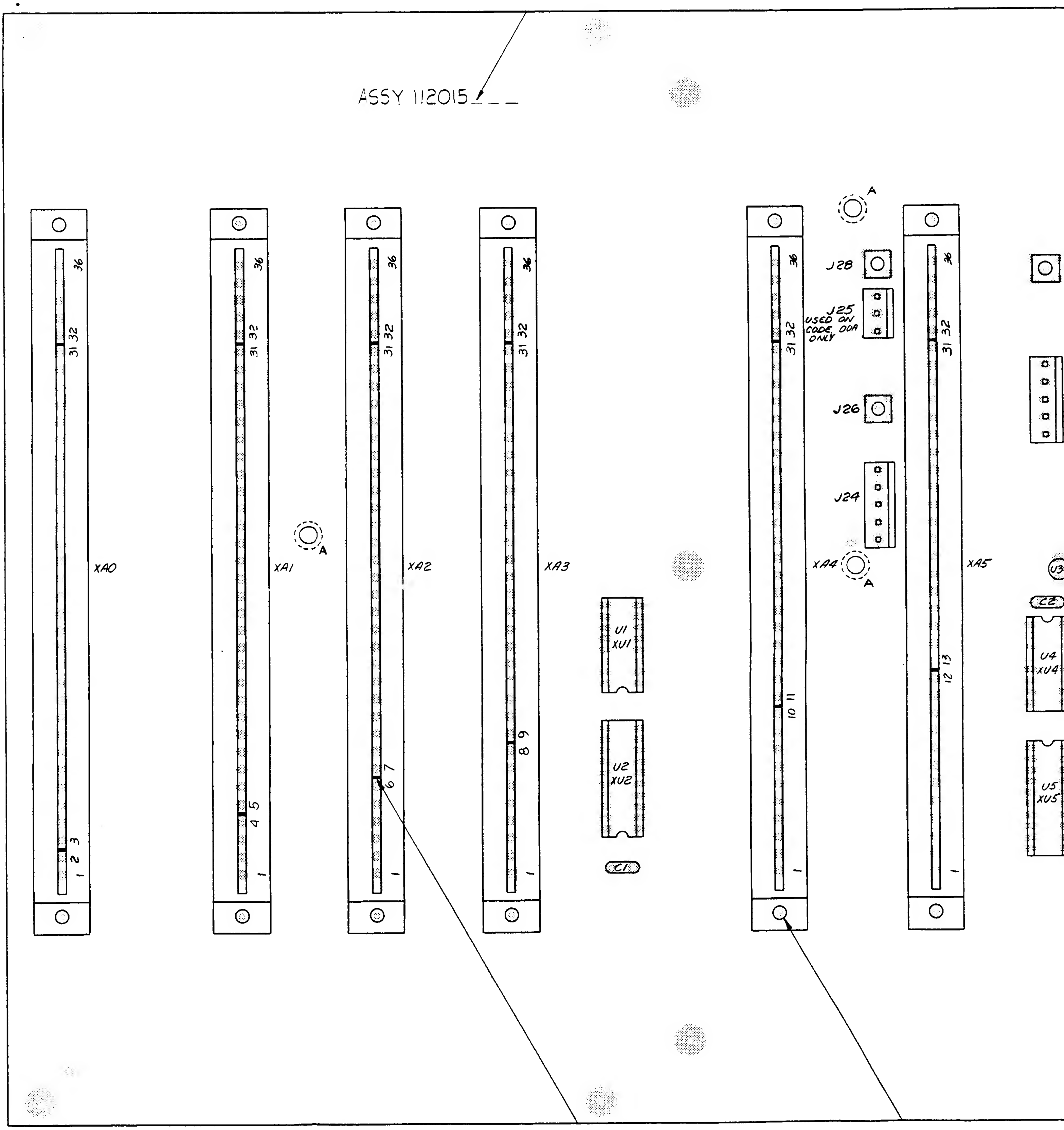
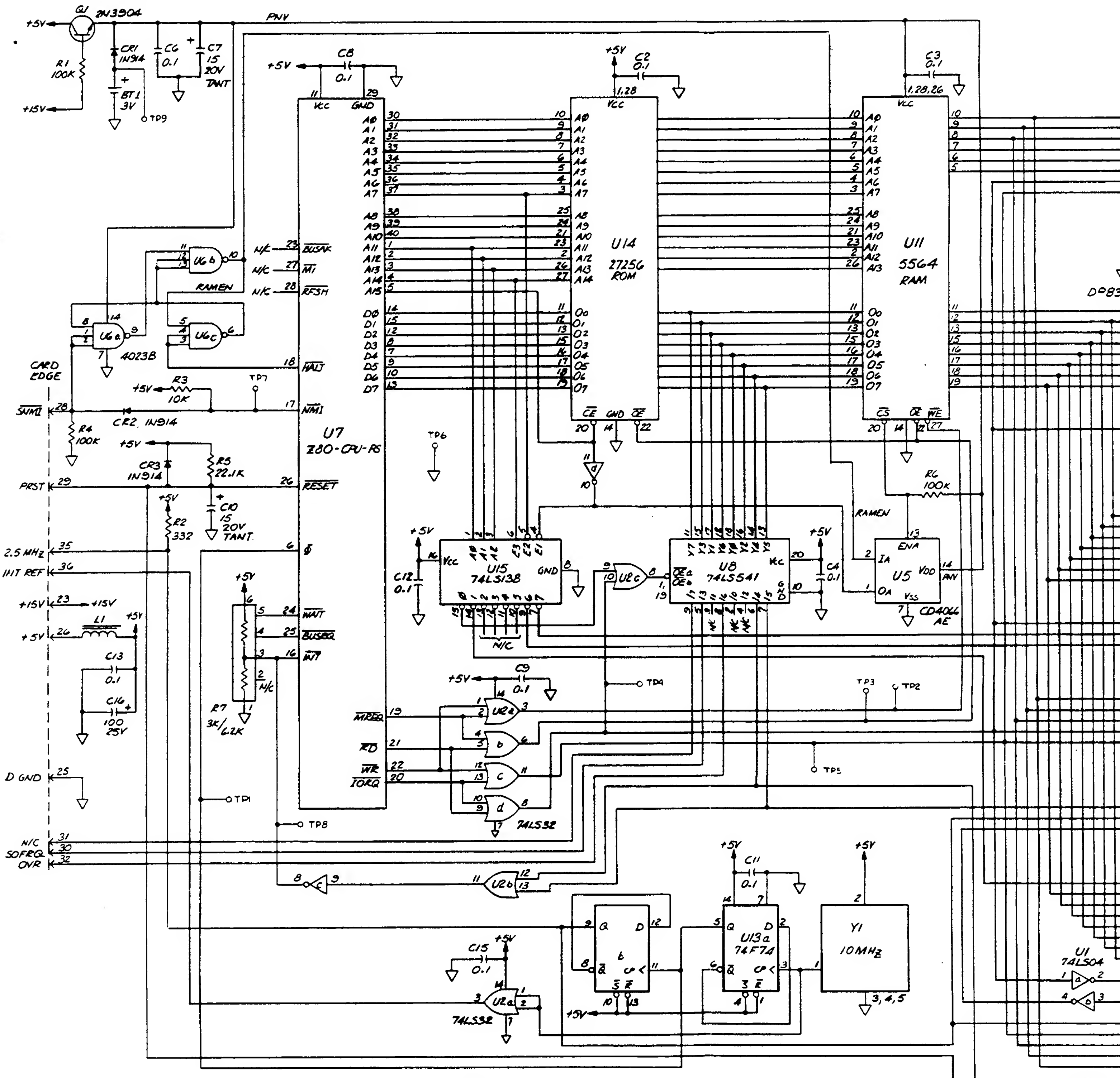


Figure 7-17. Mother Board A10 Parts Location Diagram.


ASSY 112015
XA0
XA1
XA2
XA3
XA4
XA5
J28
J25
USED ON CODE 00A ONLY
J26
J24
U1 XU1
U2 XU2
U4 XU4
U5 XU5
C1
C2
A

112015C

A5 CPU



SCHEMATIC, CPU
83148815B, SHT 15

NOTES:

1- CAPACITANCE VALUES IN µF UNLESS OTHERWISE SPECIFIED.

2- RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.

3- LAST NUMBERS USED: R9, C16, U18, CR3

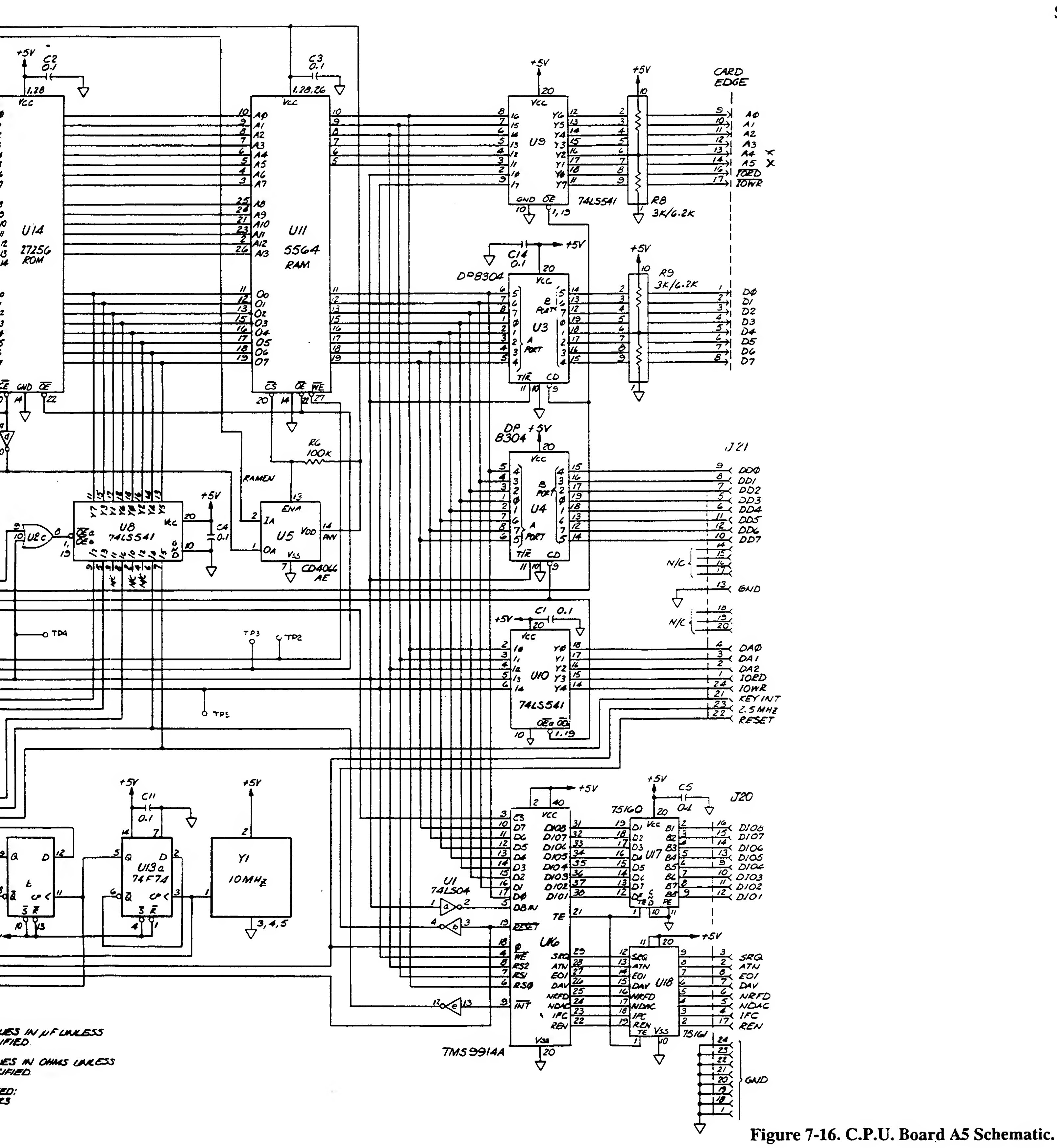


Figure 7-16. C.P.U. Board A5 Schematic.

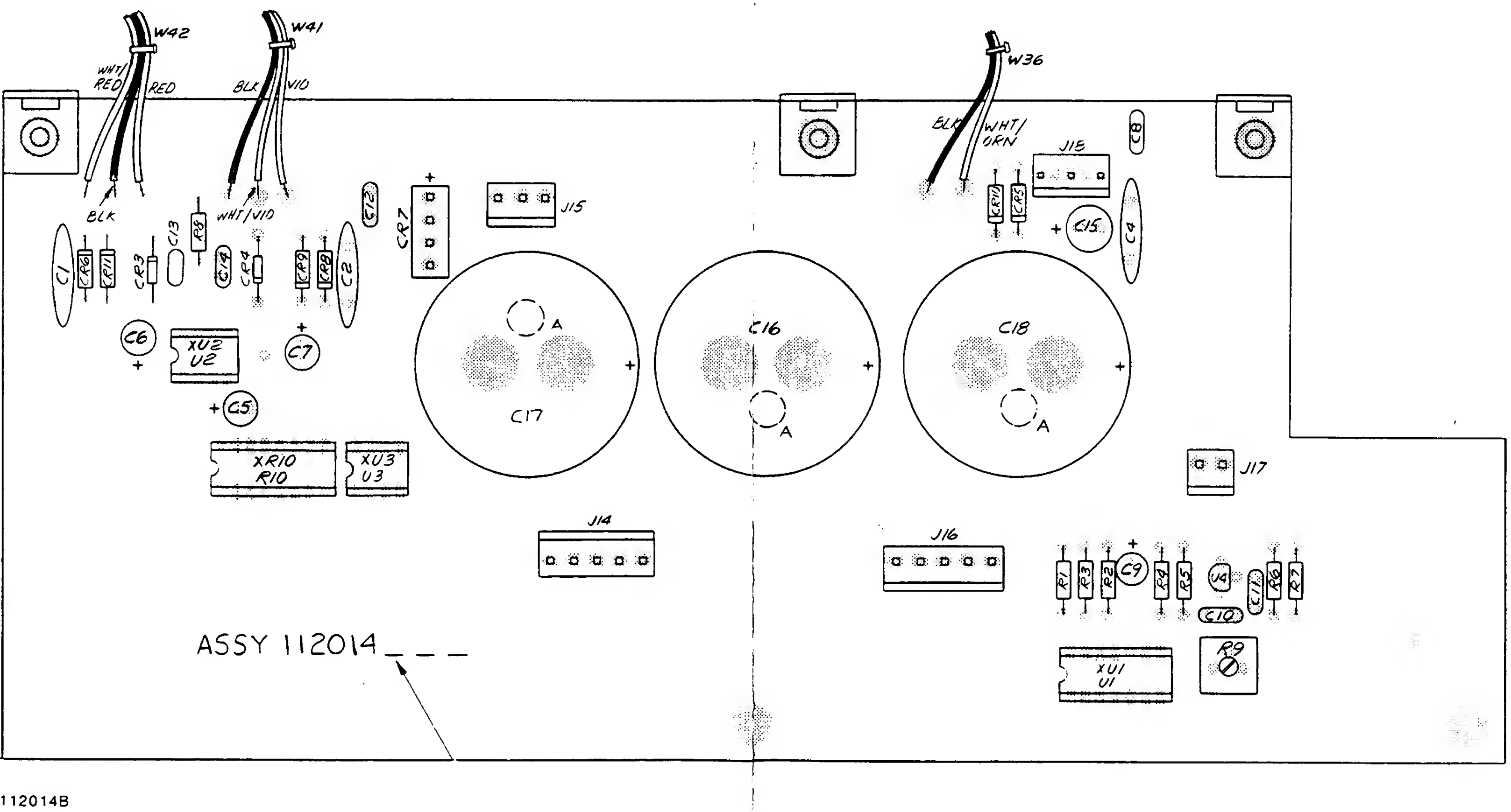
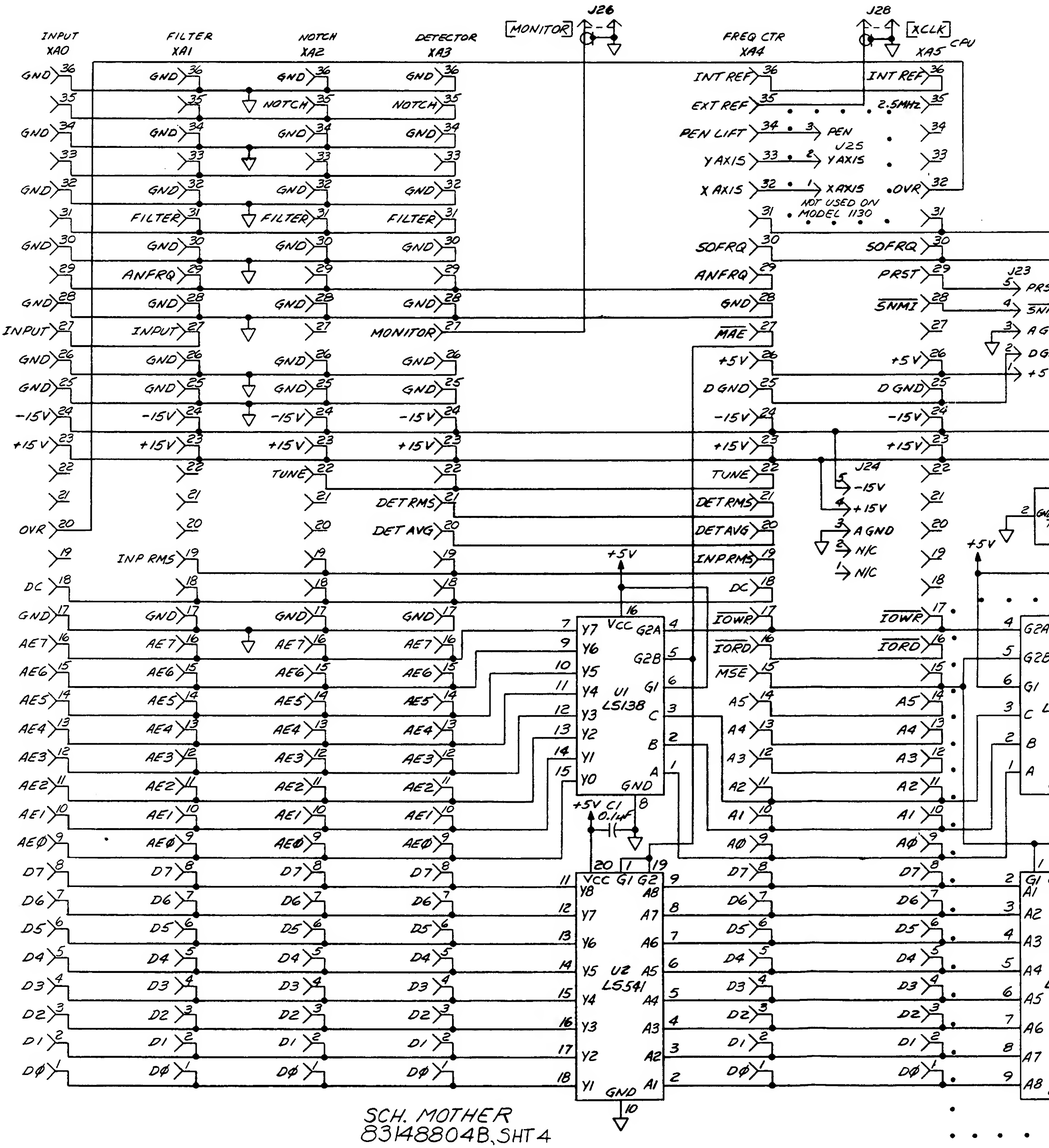


Figure 7-19. Power Supply A11 Parts Location Diagram.

A10 MOTHER



SCH. MOTHER
83148804B, SHT 4

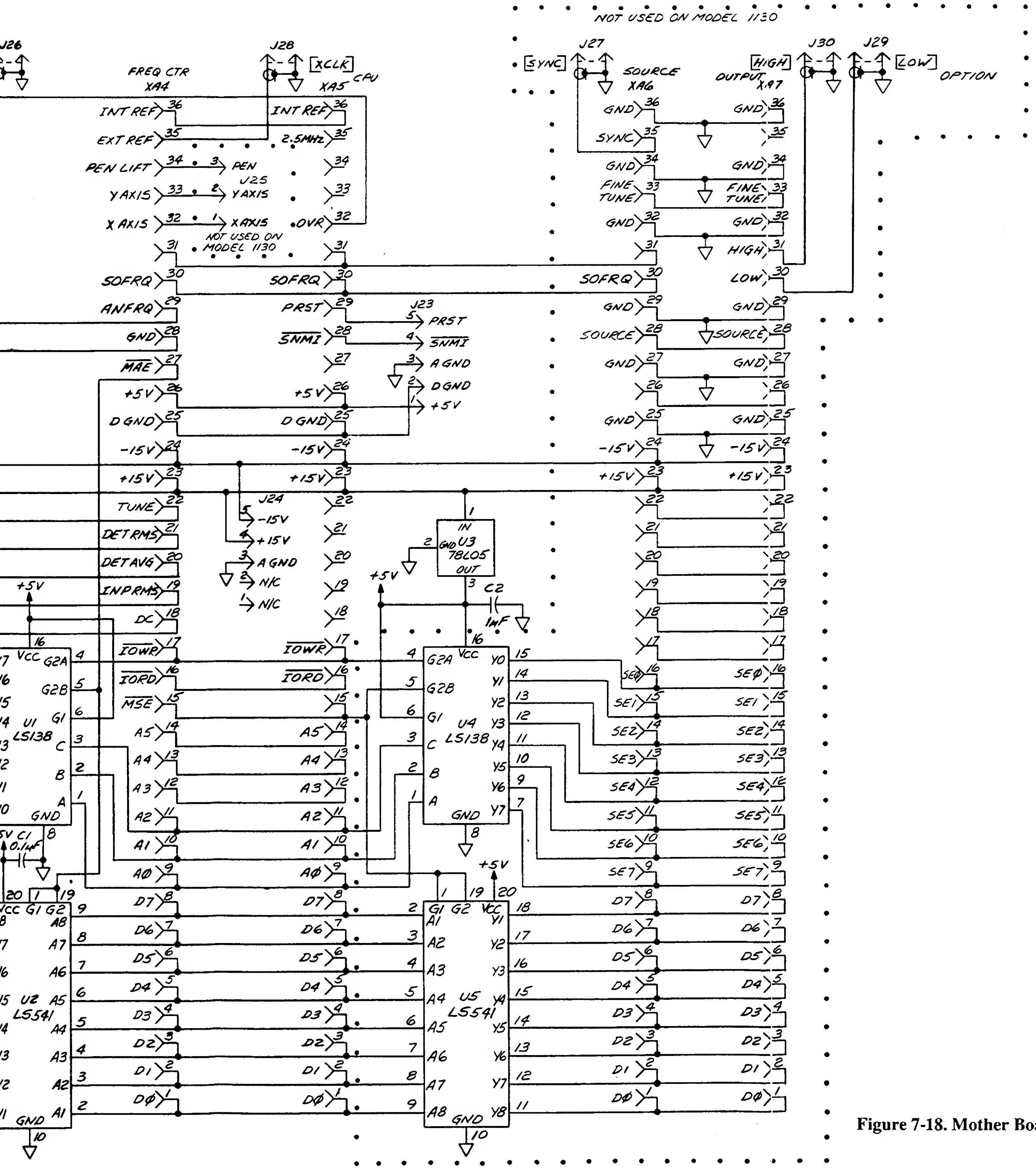


Figure 7-18. Mother Board A

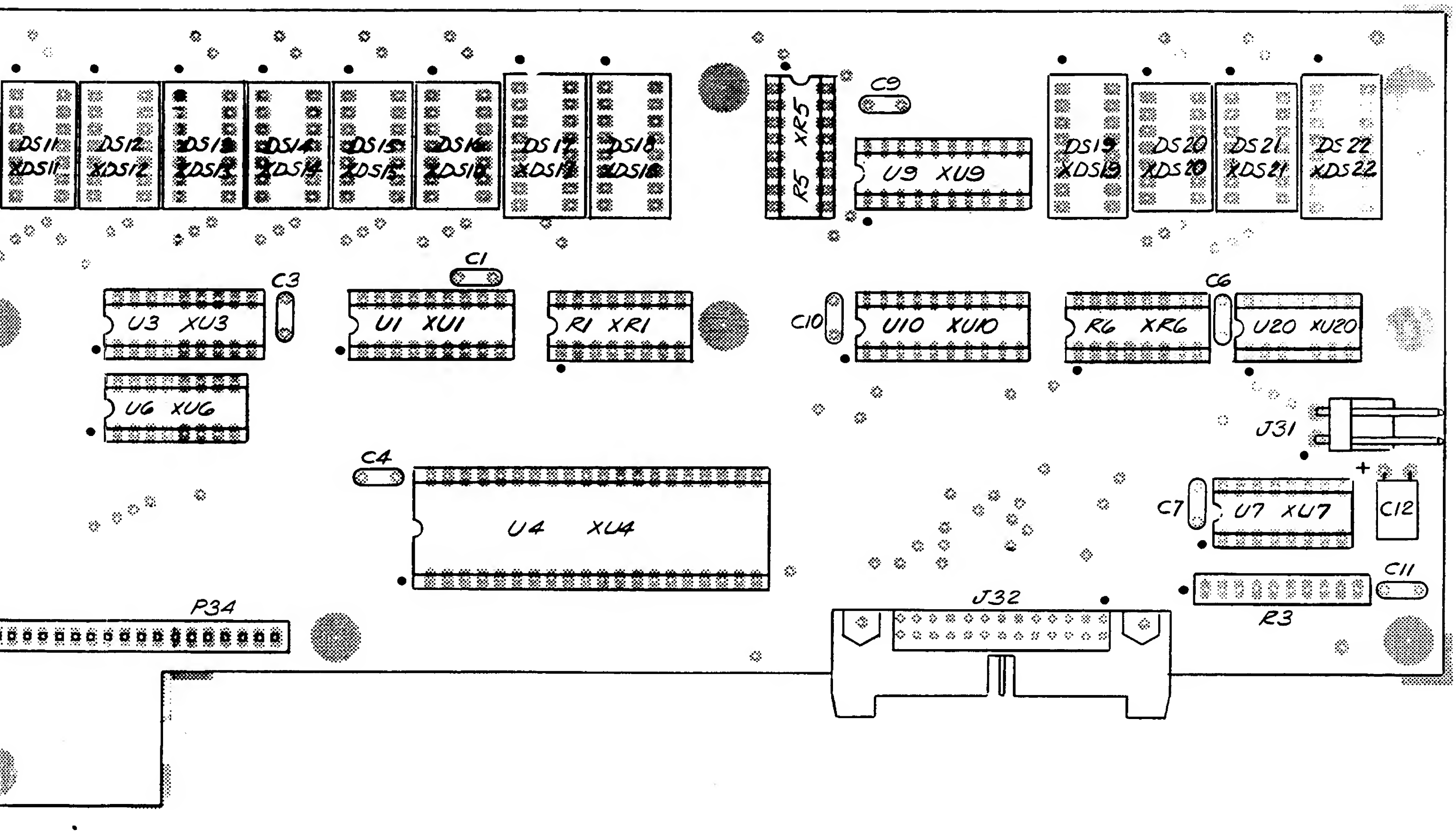
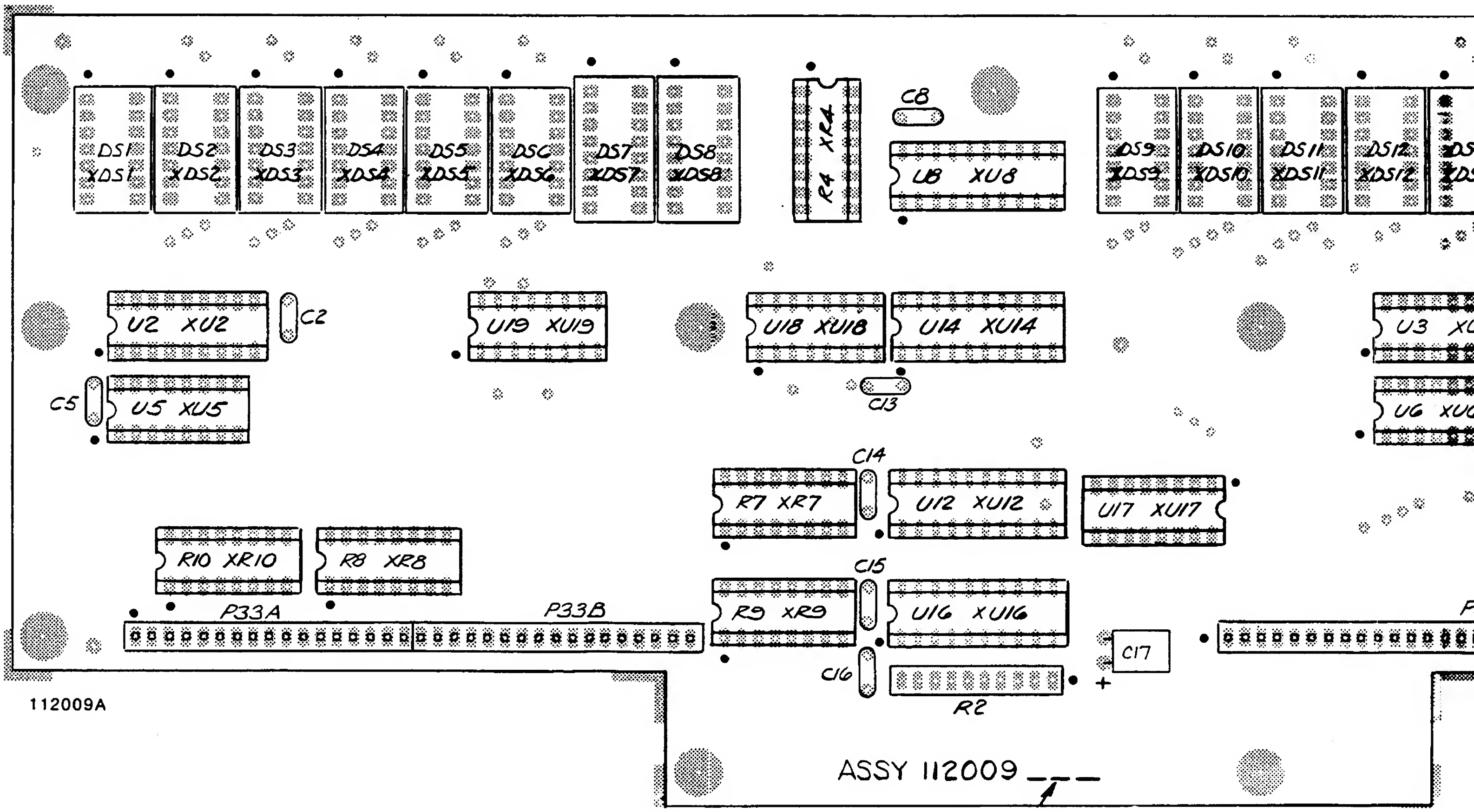
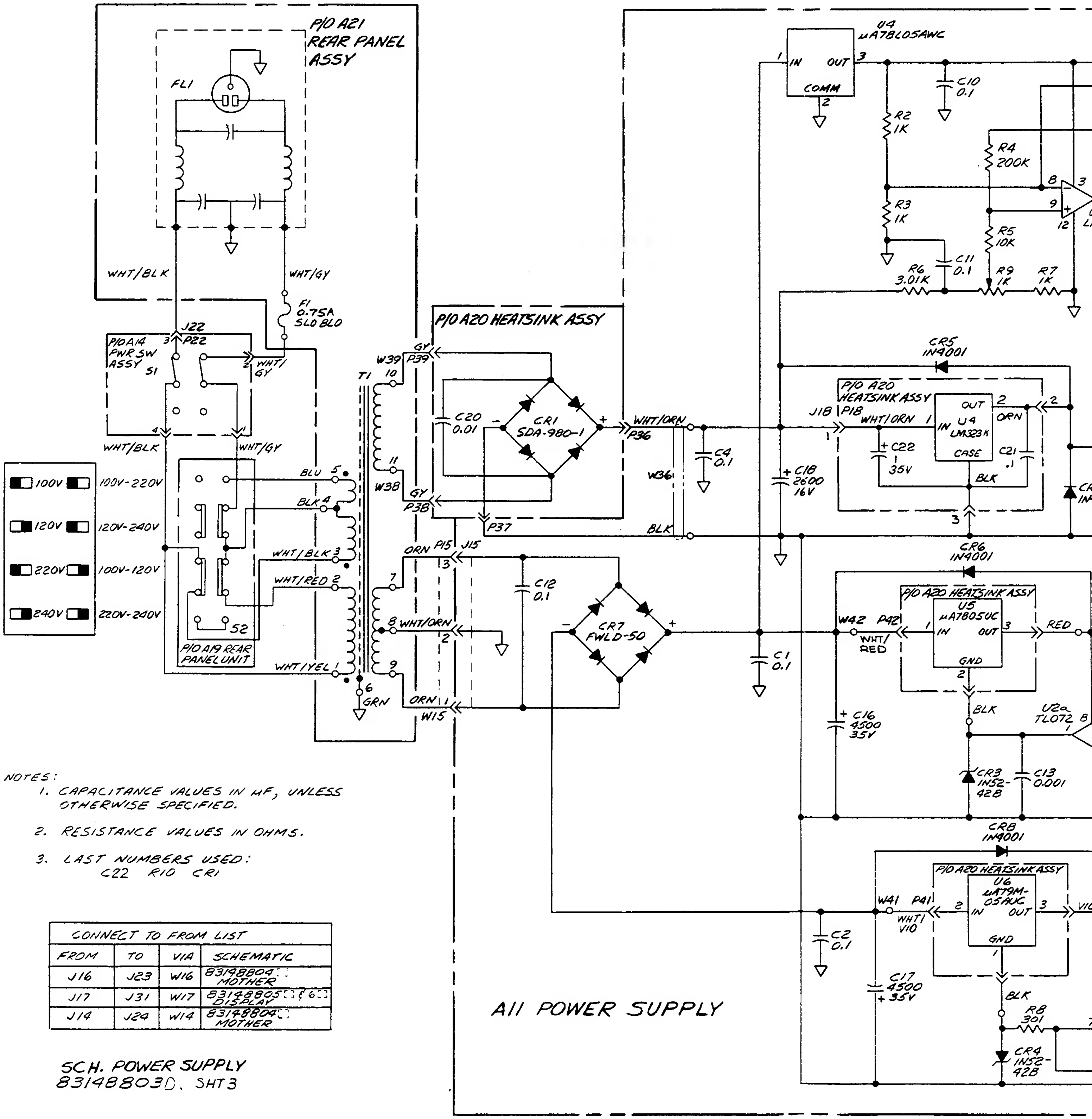


Figure 7-21. Display Board A12 Parts Location Diagram.


DS1 XDS1
DS2 XDS2
DS3 XDS3
DS4 XDS4
DS5 XDS5
DSC XDS6
DS7 XDS7
DS8 XDS8
R4 XR4
C8
U8 XU8
DS9 XDS9
DS10 XDS10
DS11 XDS11
DS12 XDS12
U2 XU2
C2
U19 XU19
U18 XU18
U14 XU14
U3
C5
U5 XU5
C13
U6
C14
R7 XR7
U12 XU12
U17 XU17
R10 XR10
R8 XR8
C15
R9 XR9
U16 XU16
P33A
P33B
C17
C16
R2
ASSY 112009 _ _ _

112009A



NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED: C22 R10 CR1

CONNECT TO FROM LIST			
FROM	TO	VIA	SCHEMATIC
J16	J23	W16	83148804 MOTHER
J17	J31	W17	83148805 DISPLAY
J14	J24	W14	83148804 MOTHER

SCH. POWER SUPPLY
83148803D, SHT3

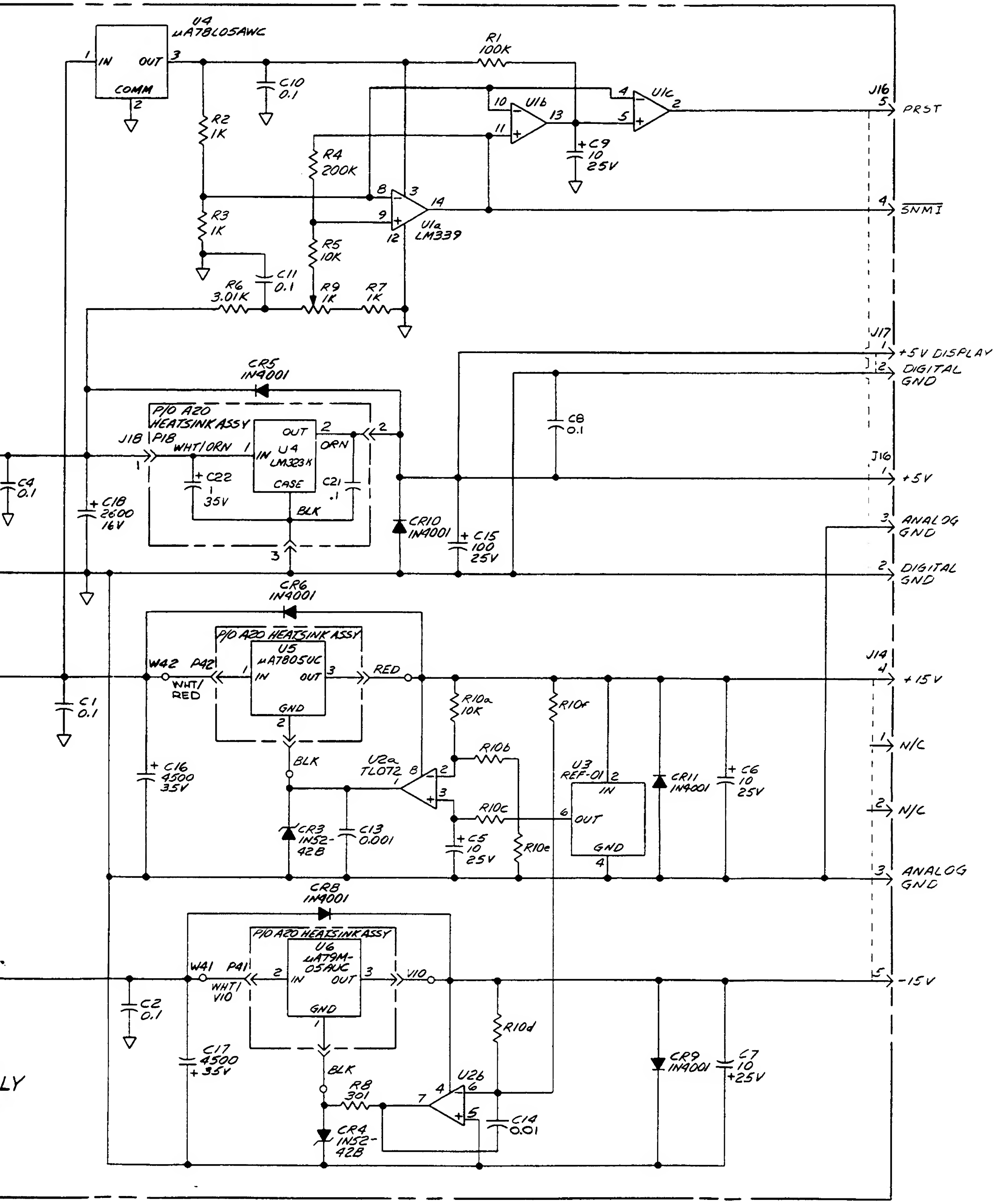
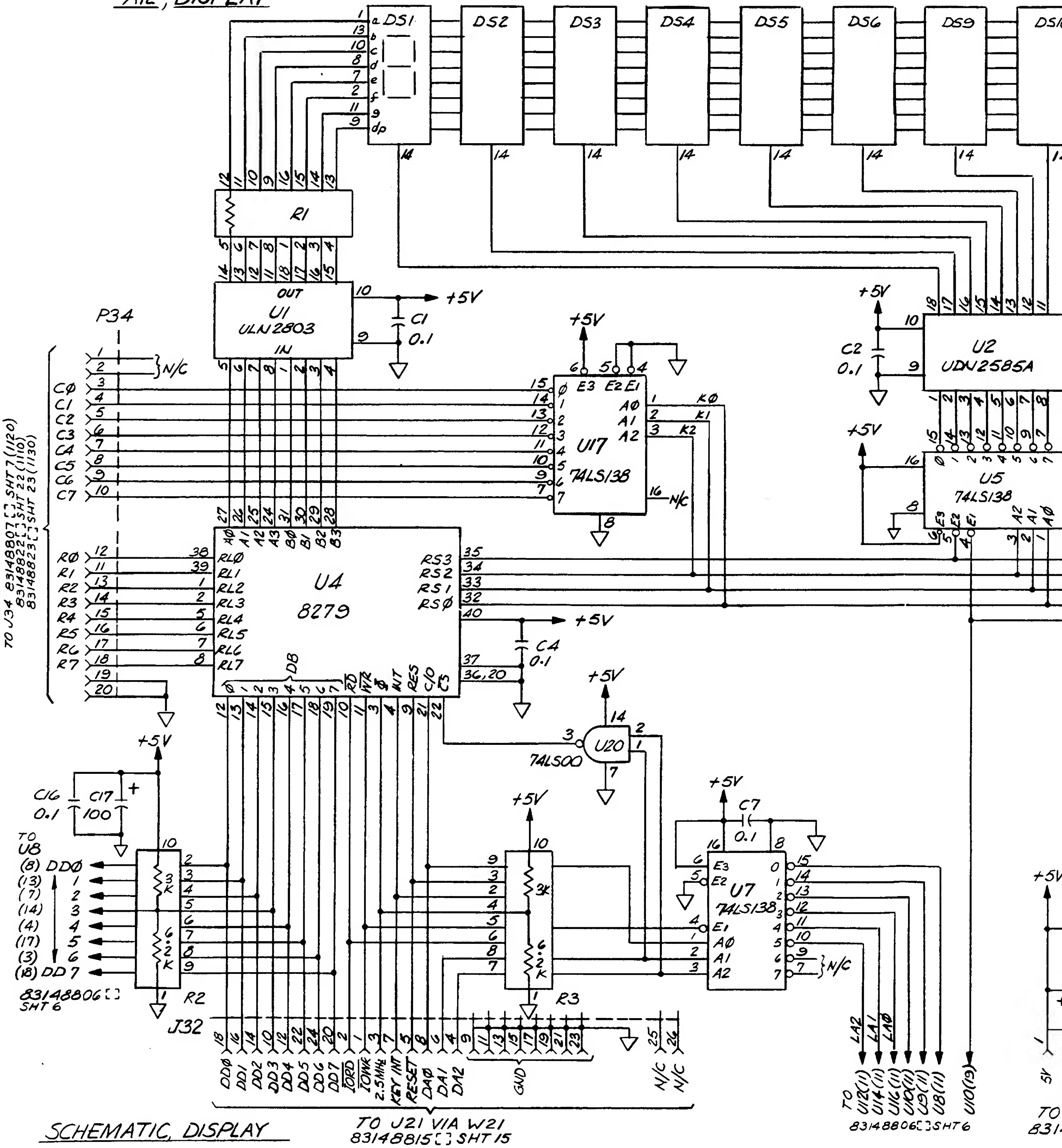
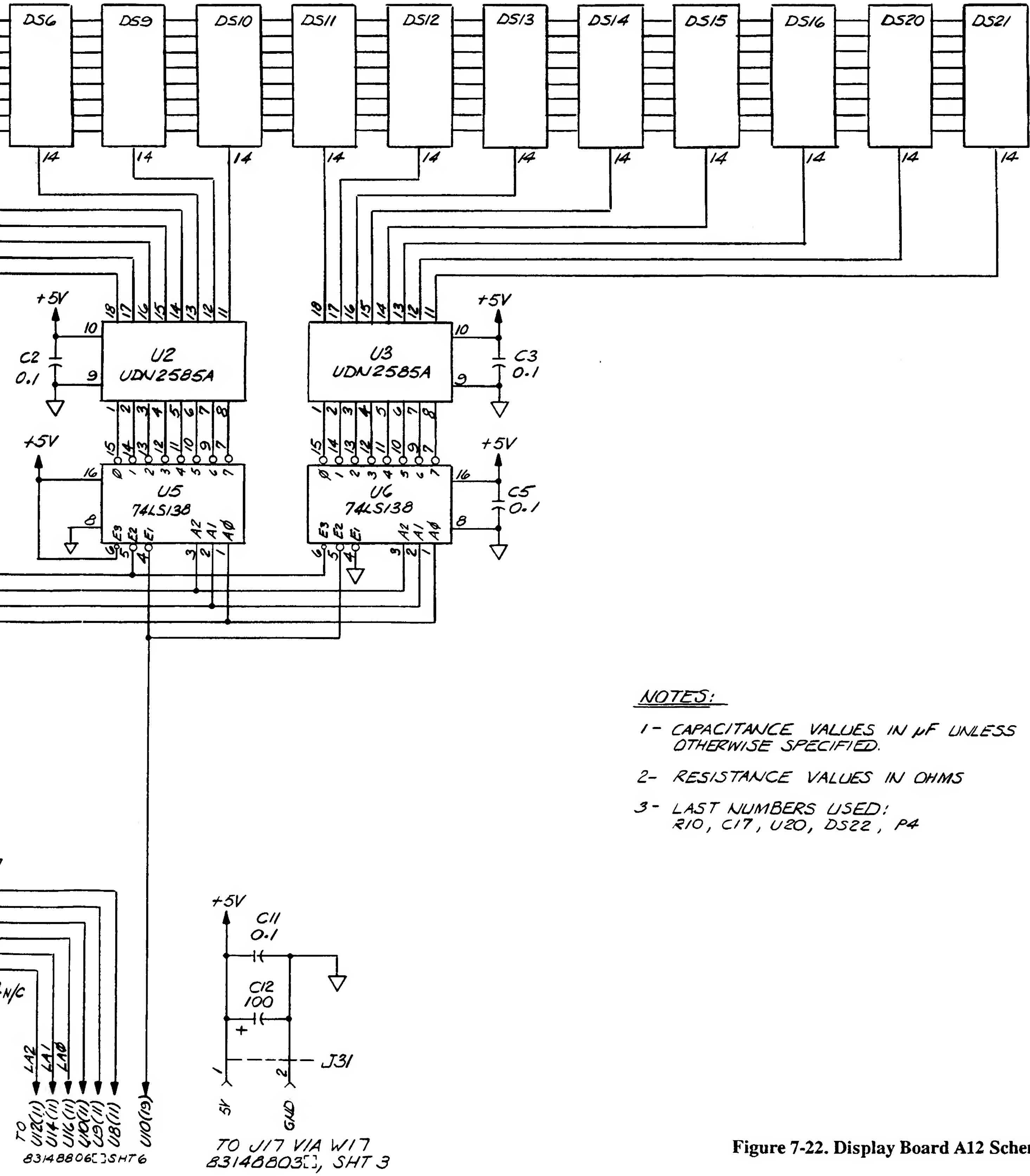


Figure 7-20. Power Supply A11 Schematic.

A12, DISPLAY



SCHEMATIC, DISPLAY
83148805A, SHT 5



NOTES:

1- CAPACITANCE VALUES IN µF UNLESS OTHERWISE SPECIFIED.

2- RESISTANCE VALUES IN OHMS

3- LAST NUMBERS USED: R10, C17, U20, DS22, P4

Figure 7-22. Display Board A12 Schematic Sheet 1.

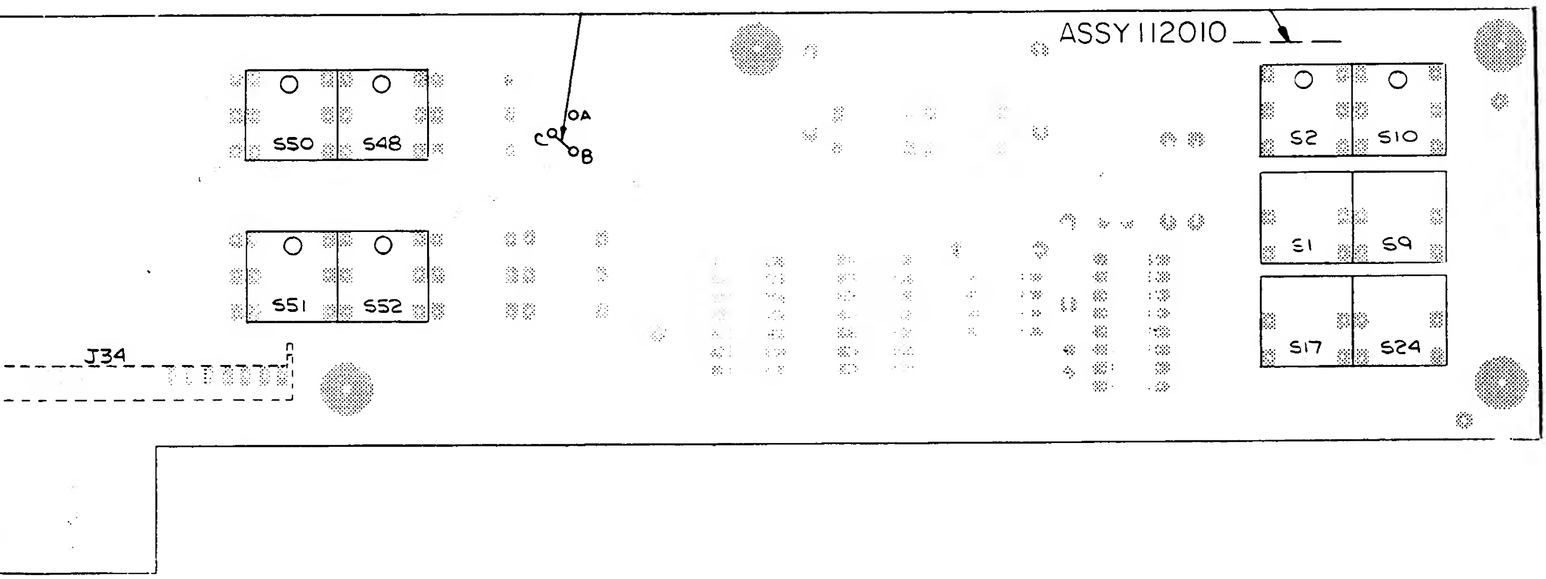
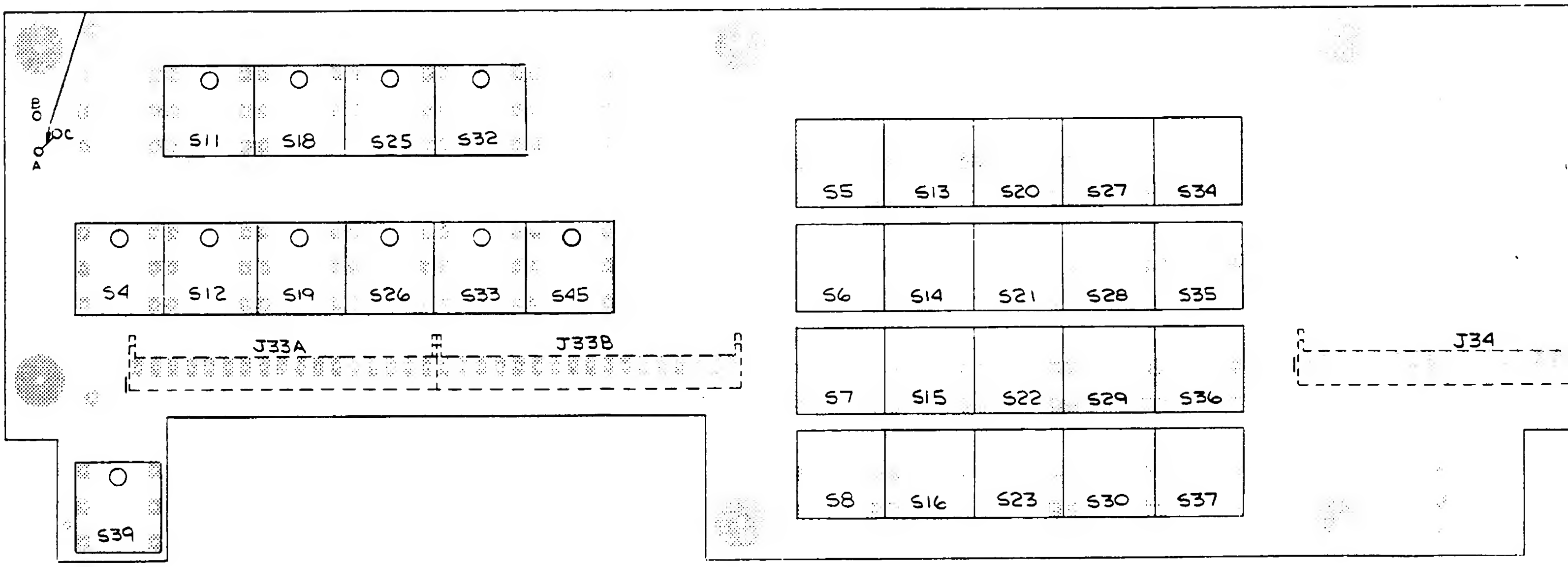
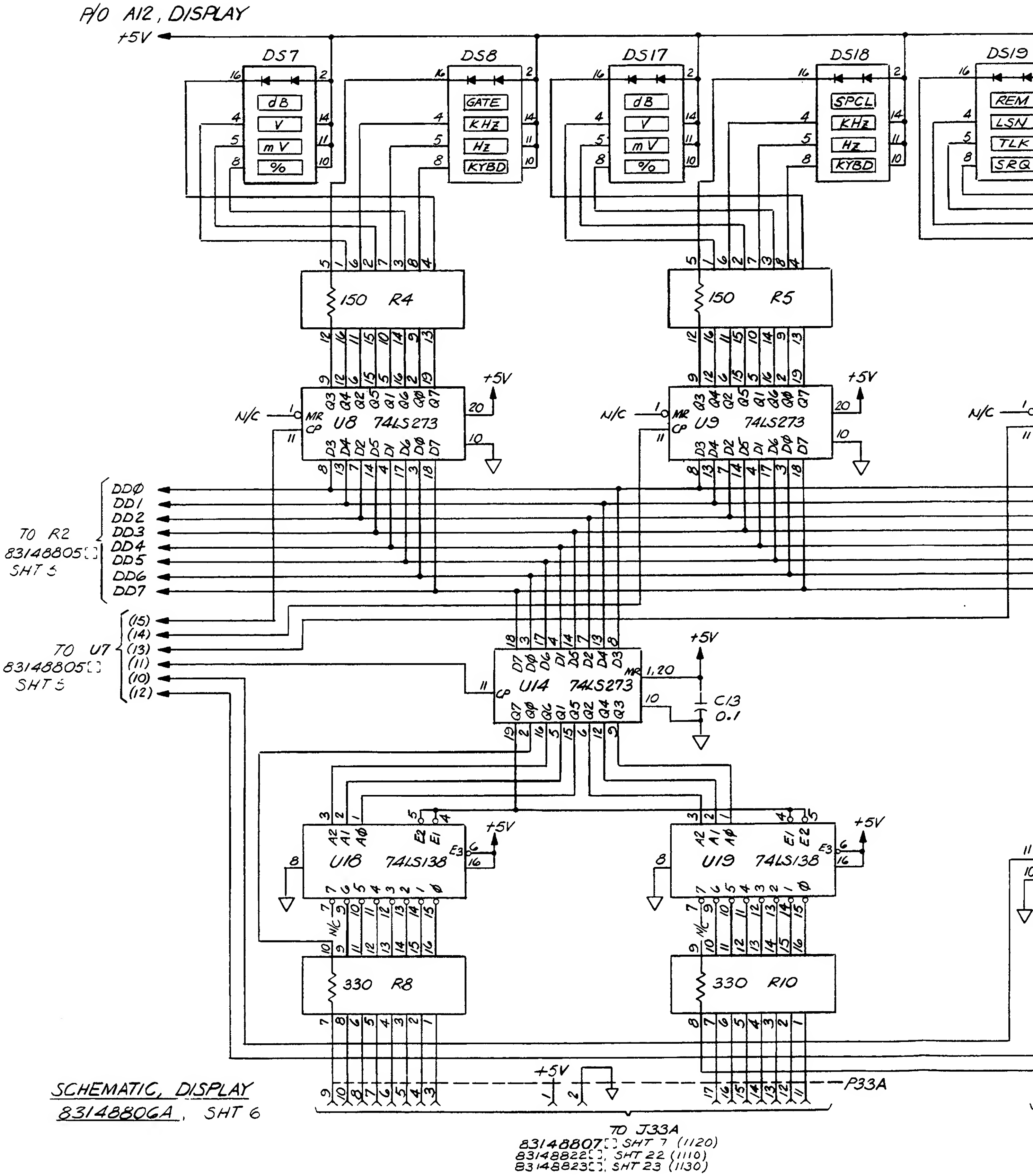


Figure 7-24. Key Board A13 Parts Location Diagram.


B
C
A
S11
S18
S25
S32
S5
S13
S20
S27
S34
S4
S12
S19
S26
S33
S45
S6
S14
S21
S28
S35
J33A
J33B
S7
S15
S22
S29
S36
J34
S39
S8
S16
S23
S30
S37

11201002A



P/O A12, DISPLAY
+5V
DS7
dB
V
mV
%
DS8
GATE
KHz
Hz
KYBD
DS17
dB
V
mV
%
DS18
SPCL
KHz
Hz
KYBD
DS19
REM
LSN
TLK
SRQ
150 R4
150 R5
N/C
U8 74LS273
U9 74LS273
DDØ
DD1
DD2
DD3
DD4
DD5
DD6
DD7
TO R2
83148805[ ]
SHT 5
TO U7
83148805[ ]
SHT 5
U14 74LS273
C13
0.1
U18 74LS138
U19 74LS138
330 R8
330 R10
P33A
SCHEMATIC, DISPLAY
83148806A, SHT 6
TO J33A
83148807[ ] SHT 7 (1120)
83148822[ ] SHT 22 (1110)
83148823[ ] SHT 23 (1130)

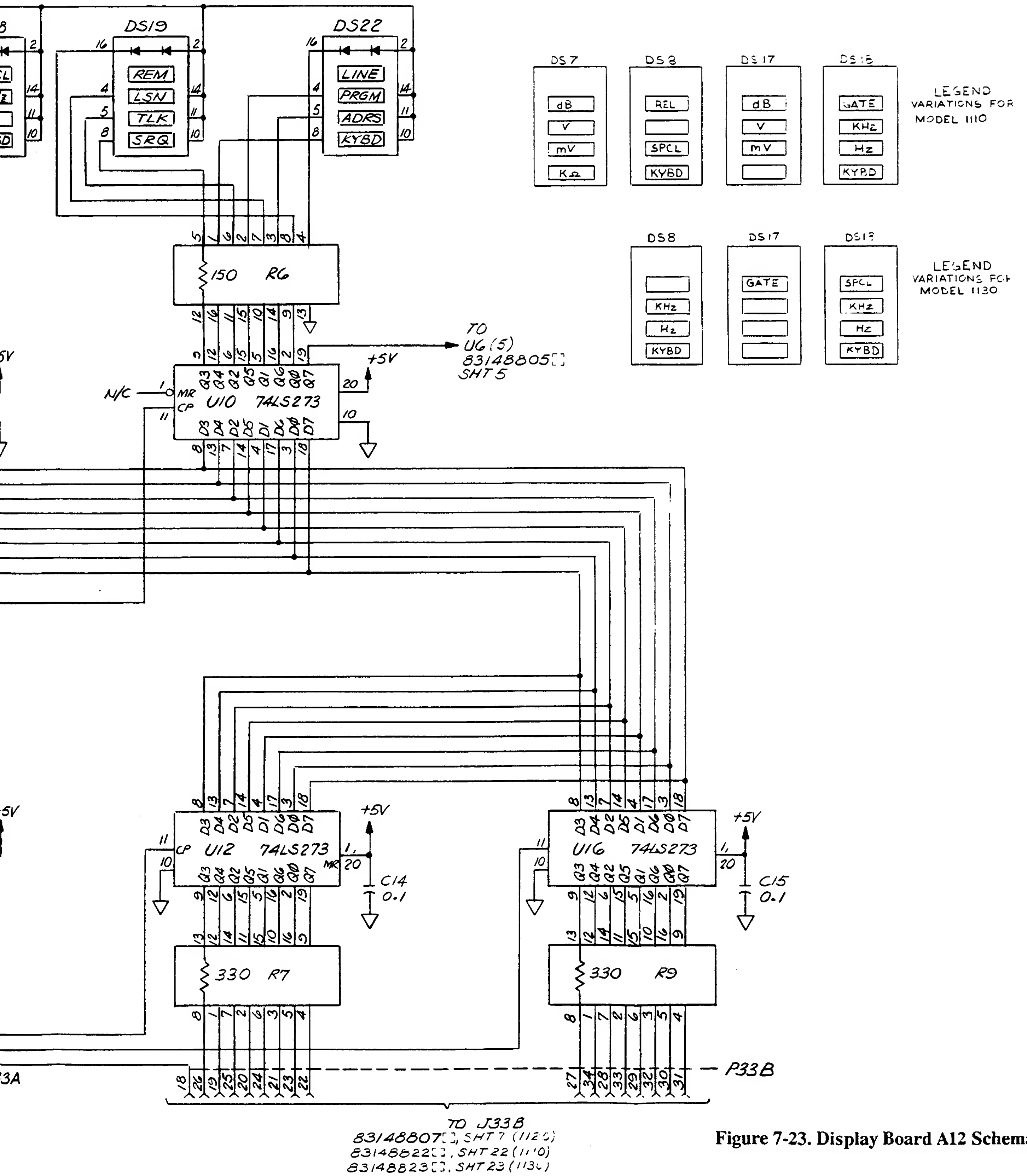
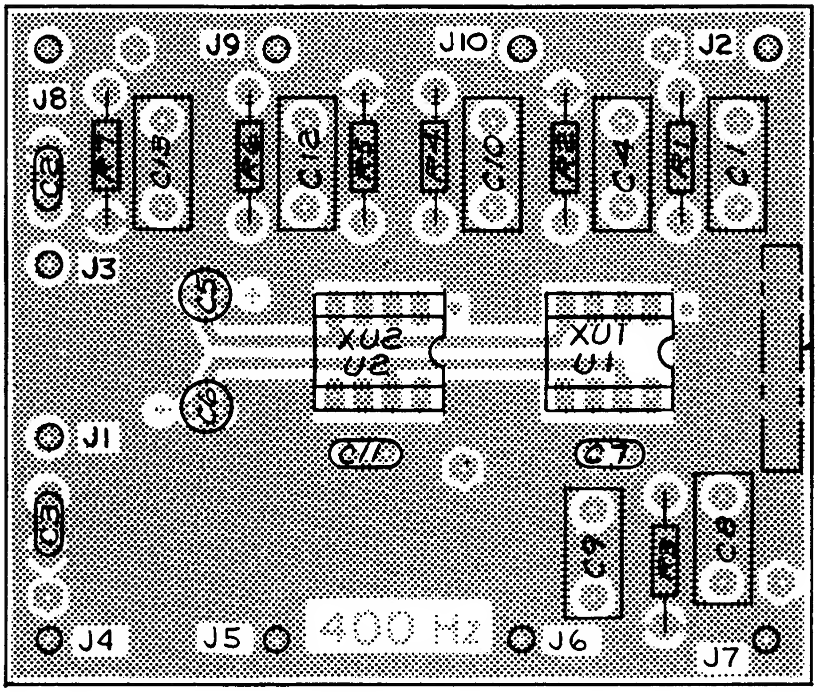


Figure 7-23. Display Board A12 Schematic Sheet 2.



112038A

Figure 7-26. 400 Hz Board A1A30 Parts Location Diagram.

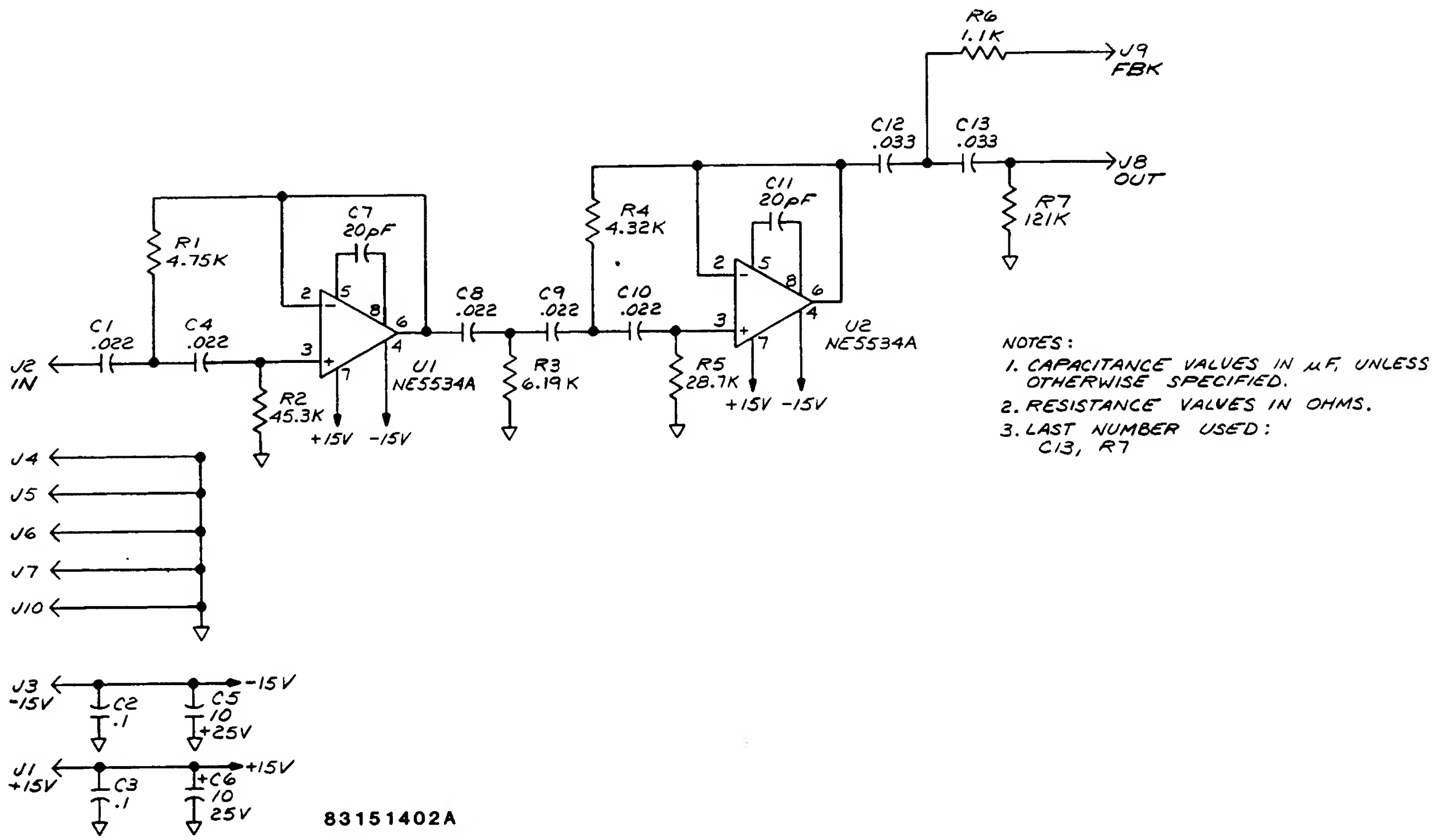


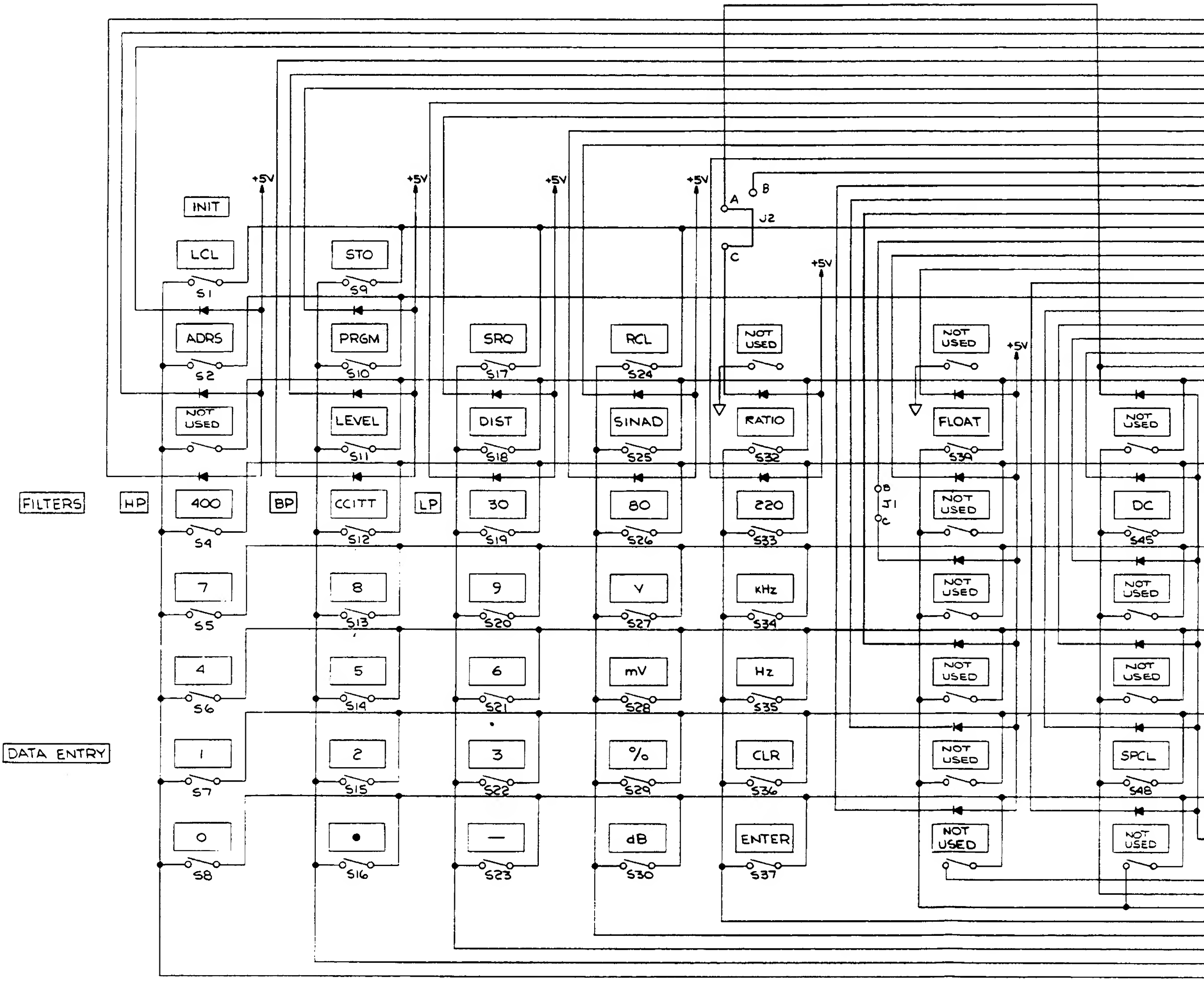
Figure 7-27. 400 Hz Board A1A30 Schematic.

NOTES:

1 [box] EXTERNAL MARKINGS.

2 LAST NUMBERS USED: S52

3 NUMBERS NOT USED: S3, 31, 38, 40, 41, 42, 43, 44, 46, 47, 49



SCHEMATIC, KEYBOARD
831488 238, SHT 23

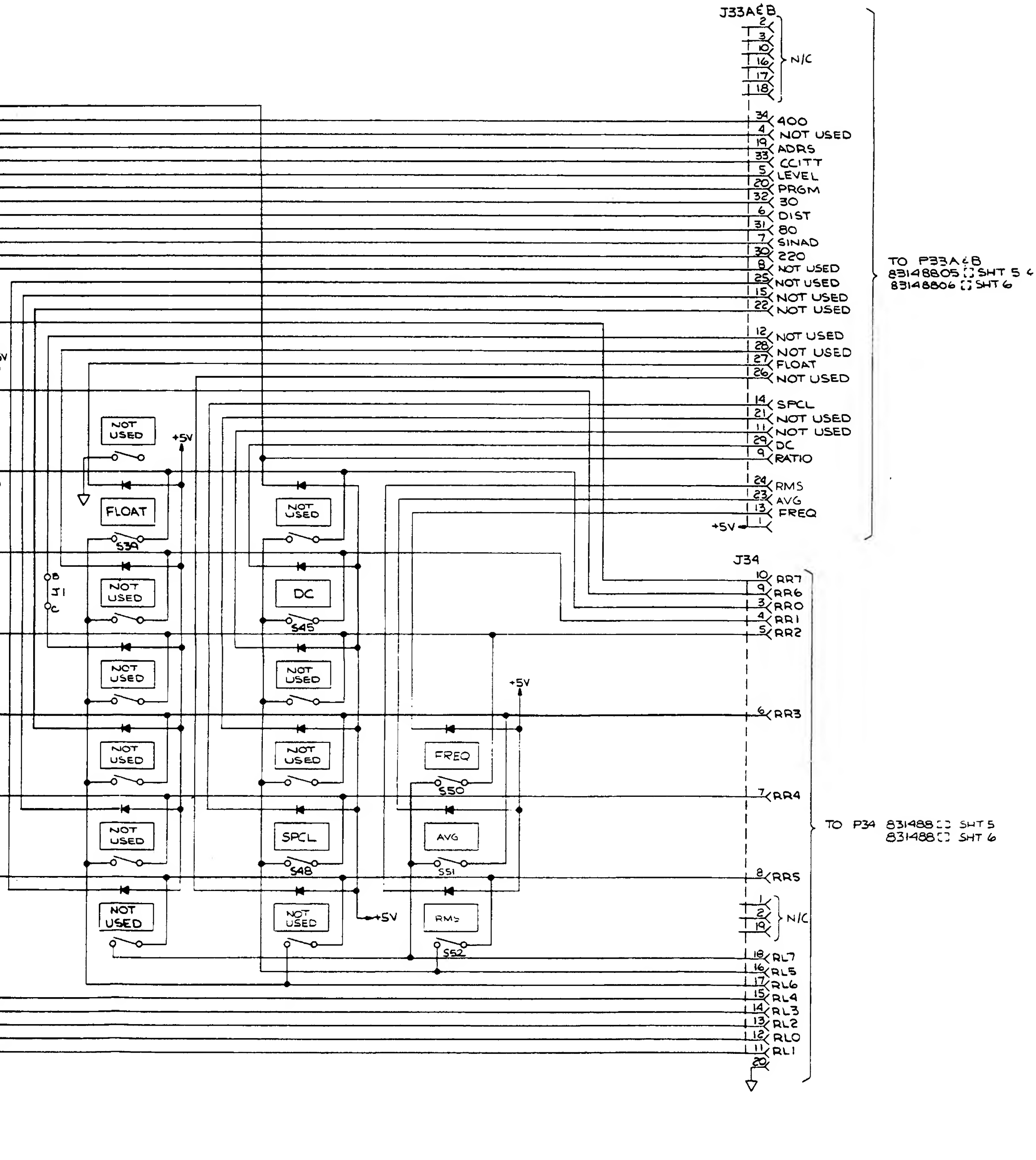
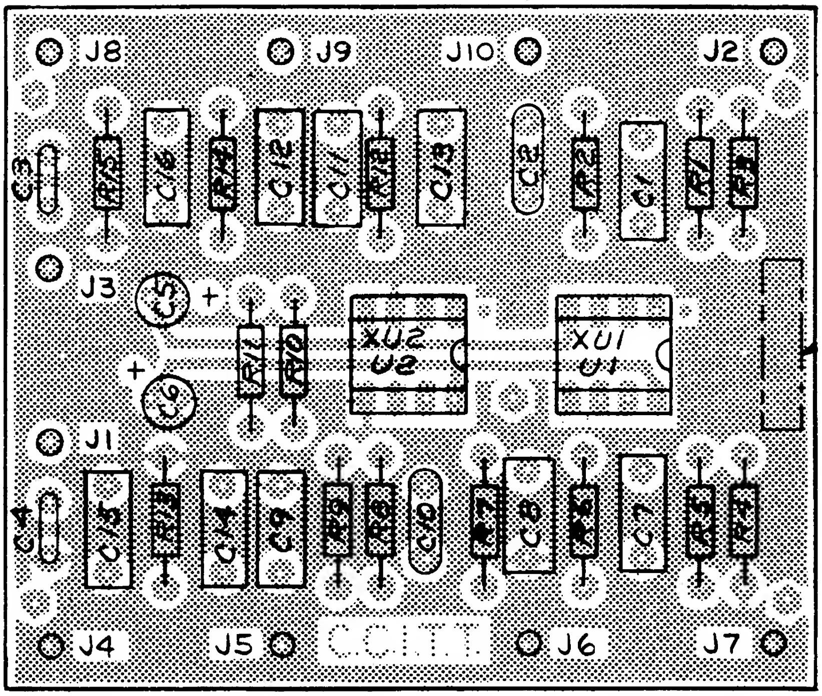
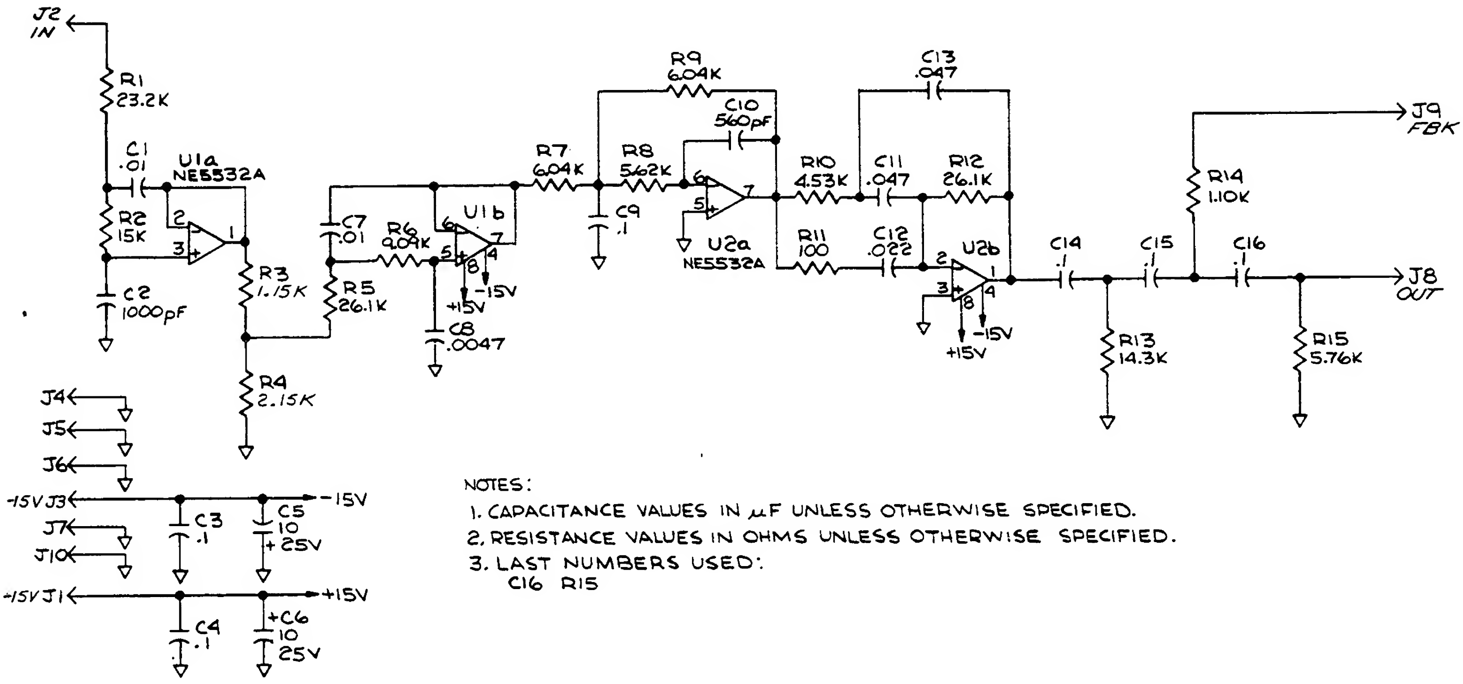


Figure 7-25. Key Board A13 Schematic.



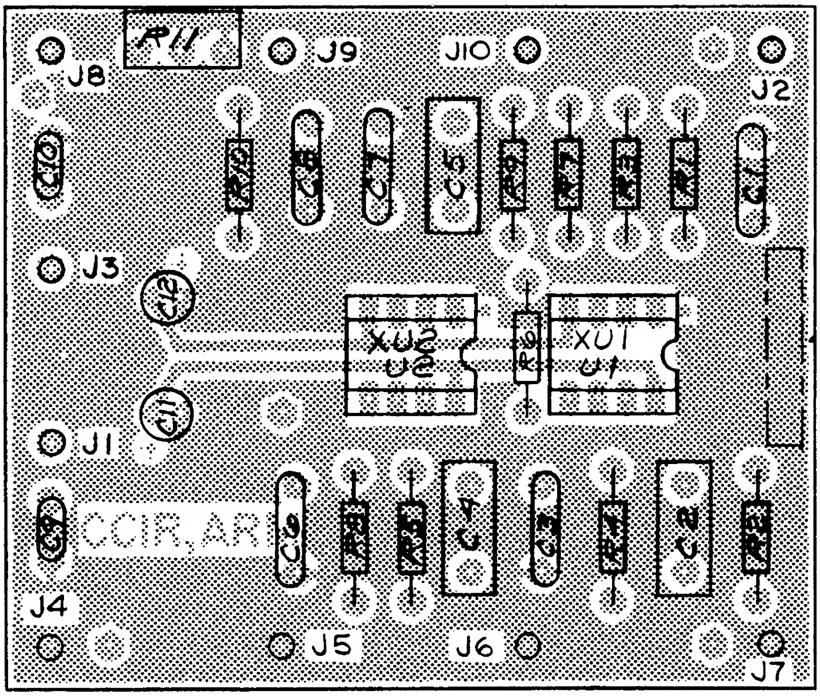
112040A

Figure 7-28. CCITT Board A1A31 Parts Location Diagram.



83151403A

Figure 7-29. CCITT Board A1A31 Schematic.



112037A

Figure 7-30. CCIR Board A1A32,A33 Parts Location Diag.

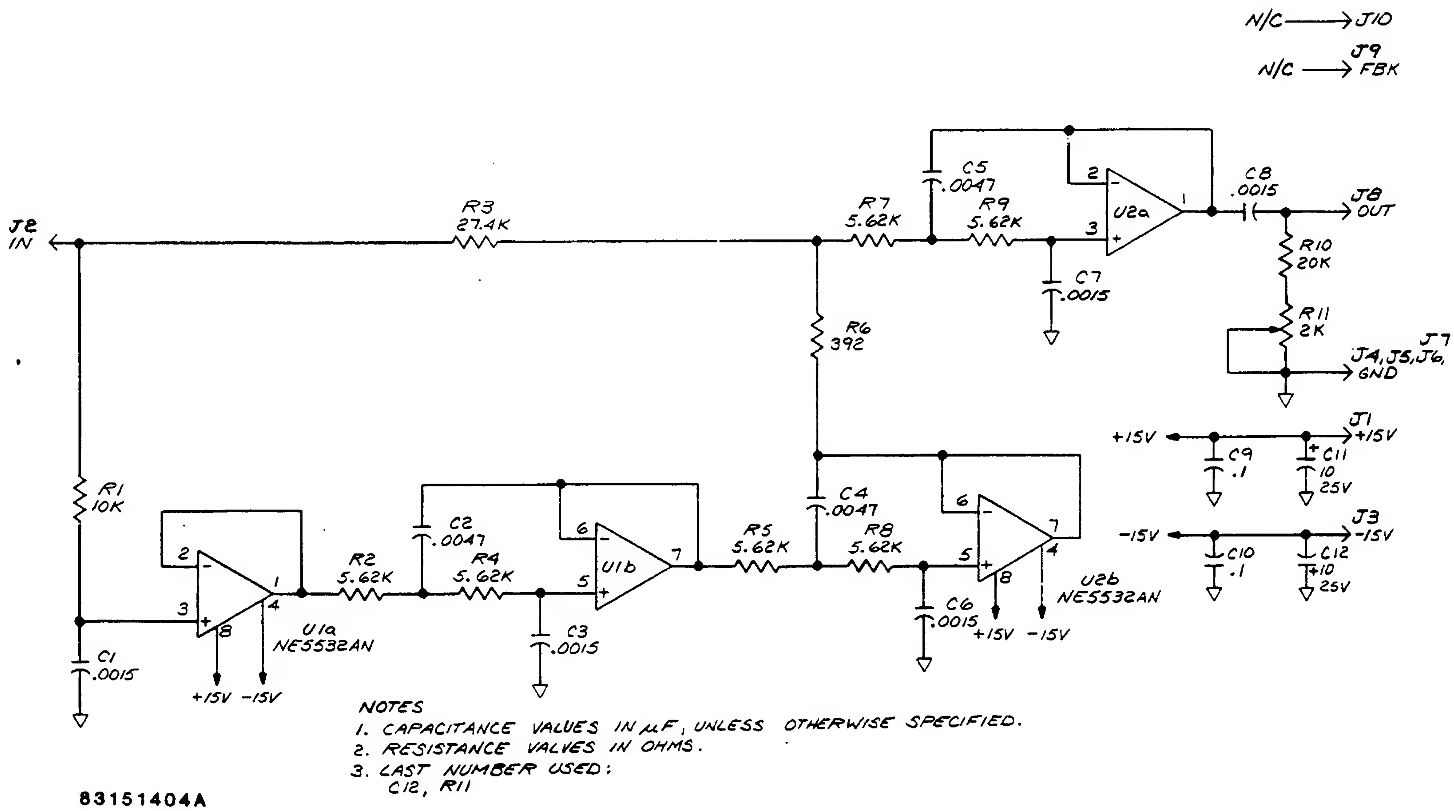


Figure 7-31. CCIR Board A1A32,A33 Schematic.

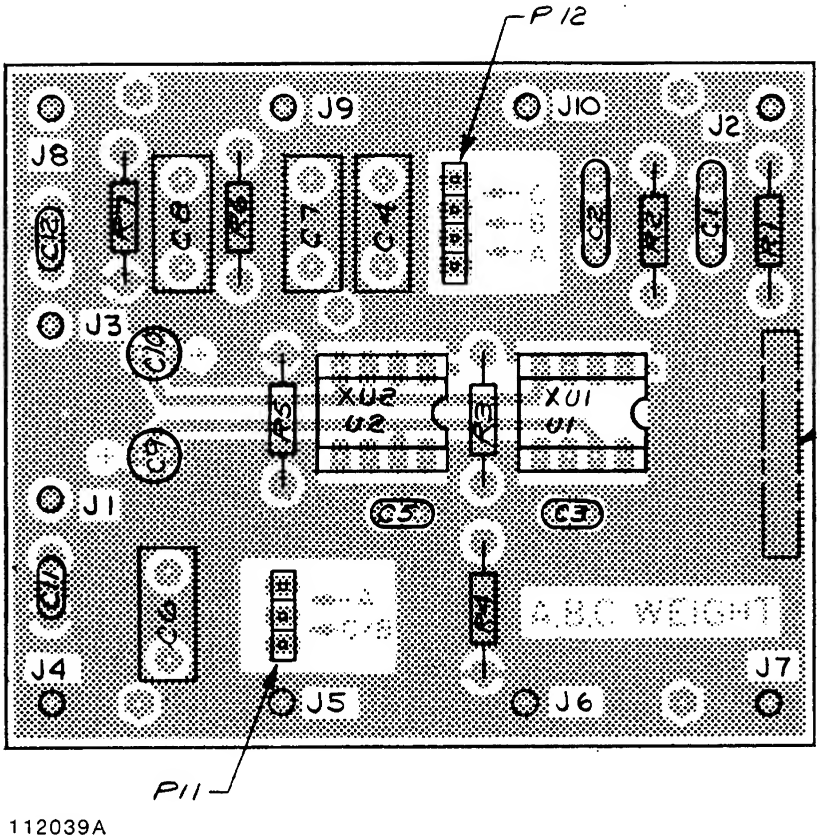
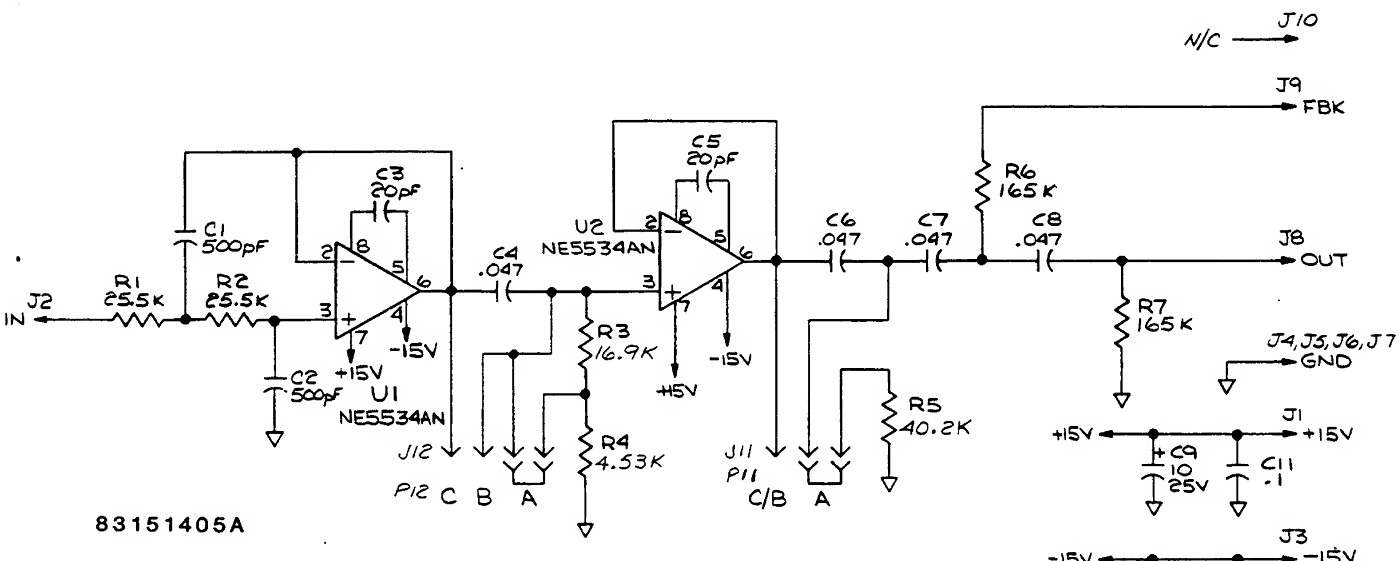
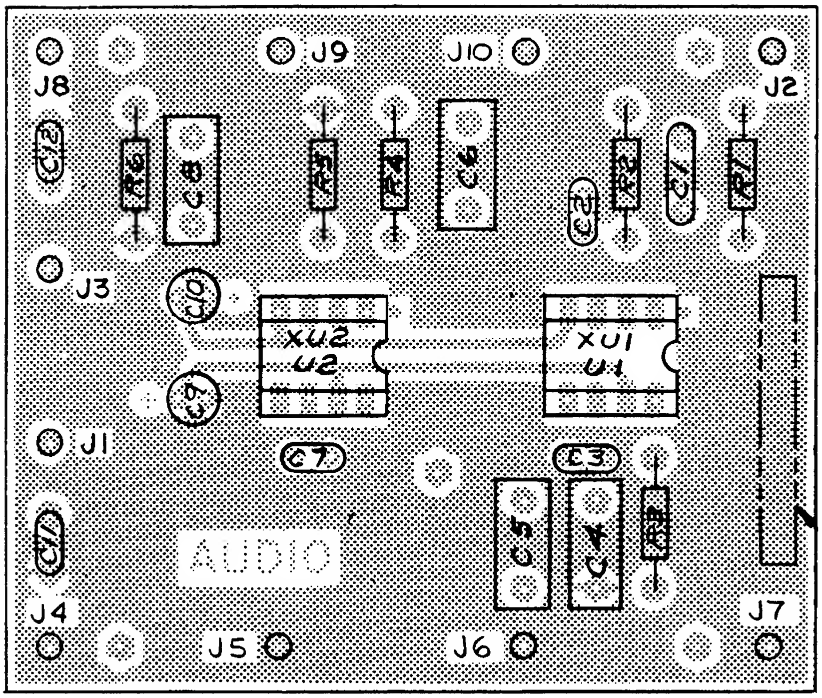


Figure 7-32. A,B,C WTNG Board A1A34,35,36 Parts Loc. Diag.



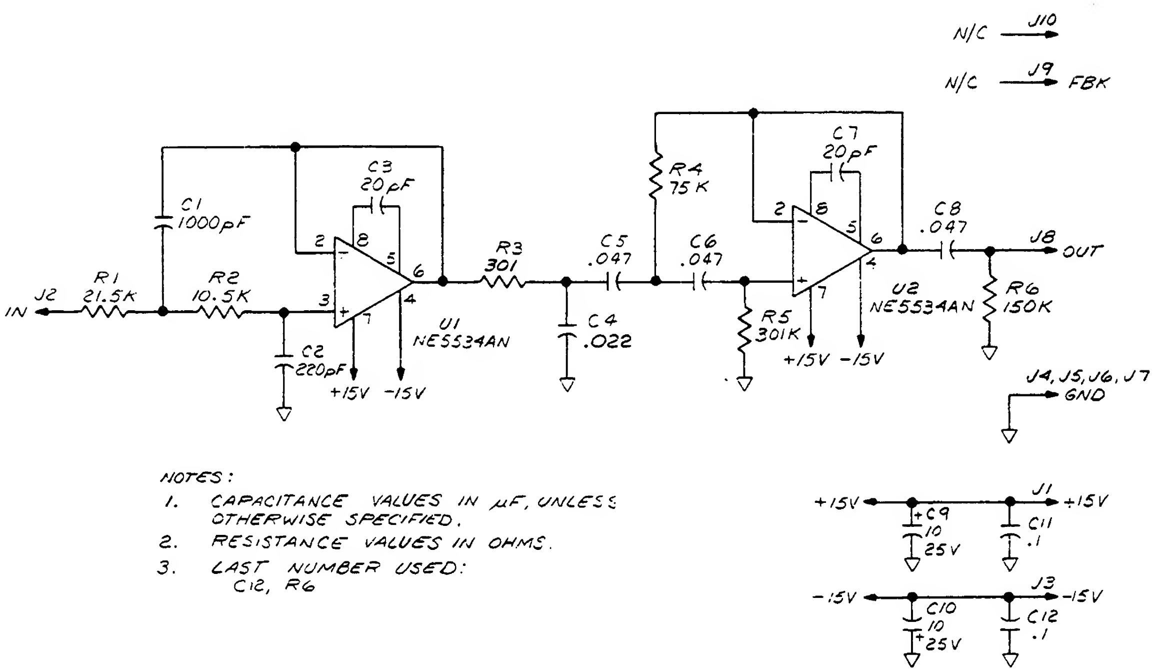
NOTES:
1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED:
C12 R7

Figure 7-33. A,B,C WTNG Board A1A34,35,36 Schematic.



112036A

Figure 7-34. AUDIO Board A1A37 Parts Location Diagram.



83151406B

Figure 7-35. AUDIO Board A1A37 Schematic.

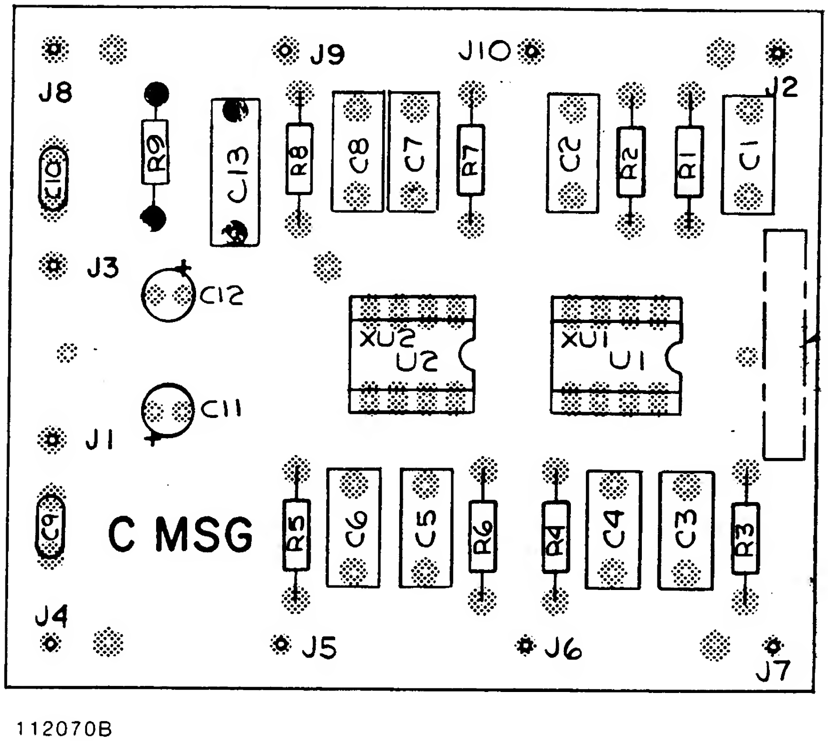


Figure 7-36. C-MESSAGE Board A1A38 Parts Location Diag.

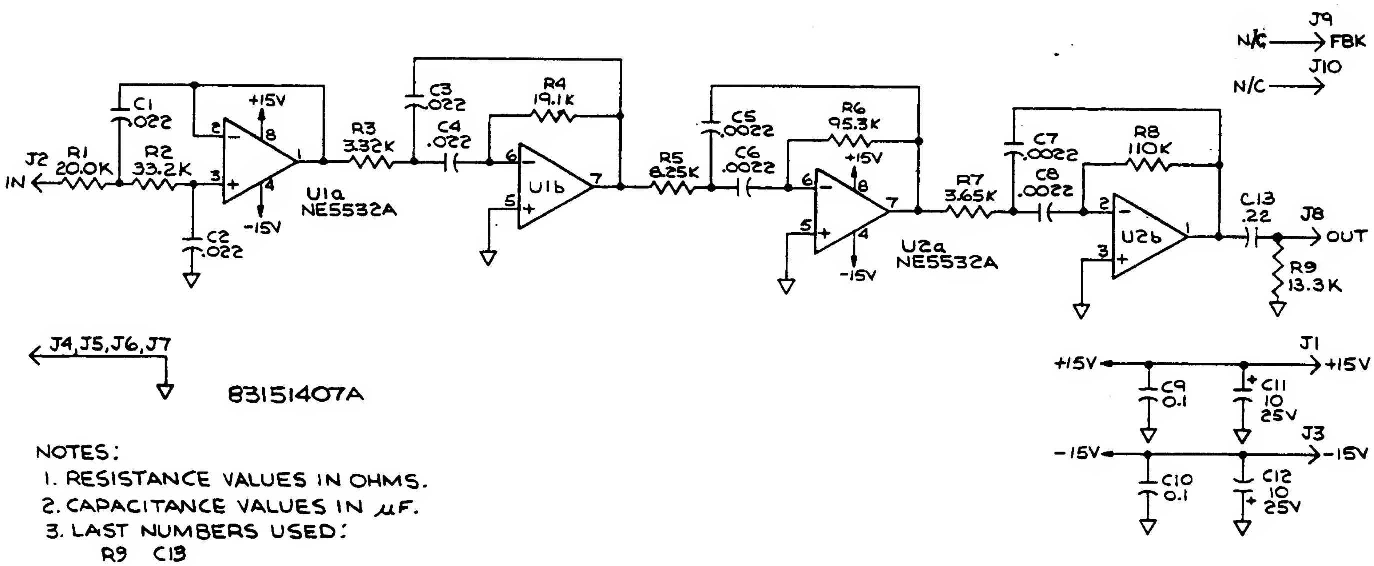


Figure 7-37. C-MESSAGE Board A1A38 Schematic.